User Guide

Digital Servo Amplifier

Models **7228AC, 7228DC, 7428AC, 7428DC**

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NOTES

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Chapter 1 Introduction

The 7XX8 Series of Digital Servo Amplifiers are high performance, DSP (Digital Signal Processor) controlled amplifiers. They control AC brushless motors with full sinusoidal commutation. AC models operate directly from AC mains. DC models operate from DC power sources, which directly rectify the line. All models have full isolation between signal and power stages. No power transformers are required.

Built using surface-mount technology, these amplifiers offer a full complement of features for AC brushless motor control. All models use industry standard ±10V analog control signals for torque or velocity control. A two-signal digital input takes step-motor command pulses for position control:

- In either CW/CCW or PLS/DIR format, or
- from quadrature encoder A/B signals.

Digital preset inputs can be used to initiate 16 predefined velocity, torque or position indexes.

A three phase MOSFET bridge output stage delivers power in four-quadrants for smooth and efficient bidirectional acceleration and deceleration of motors.

Windows software is used to configure the various gain and current limit settings and to customize the amplifiers for a wide range of loads and applications. Settings are held in nonvolatile flash memory. Communication with the

amplifier is done through an RS-232 port for easy interface to most computers. Software settings permit compensation over a wide range of load inductances to maximize bandwidth with different motors. Individual peak and continuous current limits allow high acceleration without sacrificing protection against continuous overloads.

All models are protected against output short circuits (output to output and output to ground) and heatplate overtemperature. With Reset input open, the amplifier will latch off until powered-down or the Reset input is toggled. If reset from such conditions is desired, the Reset input can be momentarily connected to ground.

A red/green status LED speeds diagnostics when the amplifier is put into operation.

Features

The Digital Servo Amplifier Model 7XX8 Servo works with DSP controlled torque, velocity or position modes using only encoder feedback from the motor. It is programmable for S-curve and trapezoidal motion files. You can select up to 16 preset modes using a PLC or Logic Hi/Lo line.

Other features include:

- No transformer required. AC version operates directly from AC mains, DC version operates from rectified line, with full optical isolation between signal and power stages.
- RS-232 digital interface used to store all settings in internal FLASH memory for selecting preset modes.
- Separate motor signal and control signal Sub-D type connectors for simpler cabling.

- Terminals for DC Buss connect to an external regenerative energy dissipator.

- Input for motor temperature sensor with settable thresholds and logic to protect motor windings.

- Command sources: Analog ±10V inputs, Digital PLS/DIR, CW/CCW, Digital presets and Data RS-232.

- Fault protections: short circuits from output to output, output to gnd, over/under voltage, motor or amplifier overtem temperatur.

Models

The following table describes the 7XX8 Series Digital Servo Amplifiers model variations.

Model	Voltage	I-Peak	I-Cont
7228AC	32~132VAC	20	10
7428AC	32~264VAC	20	10
7228DC	45~186VDC	20	10
7428DC	45~373VDC	20	10

Table 1-1 7XX8 Models

Applications

The 7XX8 Series of Digital Servo Amplifiers are compatible with a wide range of controllers. Applications include:

- Sinusoidal brushless motors
- Linear brushless motors
- X-Y stages
- Robotics
- Automated assembly machinery

Motion Explorer Software

You can manage the 7XX8 Series of Digital Servo Amplifiers from the Windows-based Copley ***Motion Explorer™*** **(CME)** software. Some of the high level tasks that you can perform from the **CME** screens include:

- Create a new motor file, or load an existing motor file.
- Generate a new amplifier file, or load an existing amplifier file.
- Adjust motor phasing.
- Fine tune current and position loops with trace feature.
- Select operating modes.
- Generate new presets that you can store in flash memory on the amplifier.
- Execute diagnostics that display statistical or graphical data about system performance.

Software Requirements

The Copley ***Motion Explorer™*** software is recommended for Windows 98 systems. The 7XX8 Series Digital Servo Amplifier interfaces to a PC via a simple RS-232 connection.

For more information about the Copley ***Motion Explorer™*** software see Chapter 5.

Terminology

Some new terminology is introduced herein with this product. The terms are defined below, and may be added to as necessary.

Term	Definition
Calculated motor data	Consists of amplifier and motor data generated by Copley Motion Explorer based on preliminary data from either .ccm files or motor specifications.
.cca (amplifier) file	A file containing all amplifier FLASH values: 16 presets and amplifier setup.
.ccm (motor) file	A file containing motor data. CME uses .cca file data to calculate values that can be stored in FLASH memory as part of preset data.
Pendant	A module that selects presets and intercepts status and error signals from the amplifier on the signal bus. It takes the place of auser equipment for purposes of application test and debug.
Preliminary motor data	Either a .ccm file or a motor specification before it has been calculated (modeled) by Copley ***Motion Explorer.***
Preset	A set of values stored in FLASH memory that contain all the information to operate the amplifier. Up to 16 presets are available.

Table 1-2 New Terms

CE Mark and UL Conformity

In compliance with CE Mark, the 7XX8 Series of Digital Servo Amplifiers are in conformity with the following standards:

EN 50081-1 : 1992	Electromagnetic Compatibility Generic Emission Standard
EN 50082-1, 1992	Electromagnetic Compatibility Generic Immunity Standard.
EN 61010-1, 1993	Safety Requirements for Electrical Equipment for Measurement, Control and Lab Use.

The 7XX8 Series of Digital Servo Amplifiers are in conformity to the following UL standard.

UL 508C	Standard for Safety, Power Conversion Equipment.

Unpacking and Inspection

Verify that the model number(s) of the product match your order. Refer to the **Read Me First** document for a parts checklist, cabling connections and **Copley Motion Explorer™** software installation instructions.

Technical Support

For technical support, you may contact us in several ways:

- Online at our web site: www.copleycontrols.com
- Email: sales@copleycontrols.com
- Telephone: (781) 329- 8200
- Fax: (781) 329-4055

Safety

Review the safety guidelines provided below.

DANGER!

HAZARDOUS VOLTAGES

Exercise caution when installing and adjusting.

WARNING!

***DO NOT** make connections to motor or drive with power applied!*

WARNING!

***DO NOT** spin motors with power off.*
Voltages generated by the motor can damage drives!

WARNING!

***DO NOT** switch operating modes with out using precautions.*
Values set for one operating mode may not be proper for another!

NOTE!

***DO** connect drives using good wiring and workmanship practices.*

NOTE!

***DO** operate drives within specifications provided in this manual.*

NOTE!

***DO** disconnect motors from loads while setting-up or servicing systems.*

Chapter 2 Amplifier Connections

In general, use the ***Copley Motion Explorer™*** Kits' **Read Me First** sheet for connection of the amplifier to:

- AC (or DC) power
- A 3-phase brushless motor
- Quadrature encoders
- The control pendant or controller
- PC or laptop (running ***Copley Motion Explorer™***)

Should you require it during installation, this chapter provides specifics about amplifier connectors, including:

- Ground
- AC/DC Power and Motor Phase Connector (J1)
- Motor Connector (J2)
- Signal Connector (J3)
- Data Connector (J4)

Figure 2-1 is a functional diagram of amplifier connections.

At the end of this chapter, you'll find information about the amplifier's signal module and* Status *indicator.

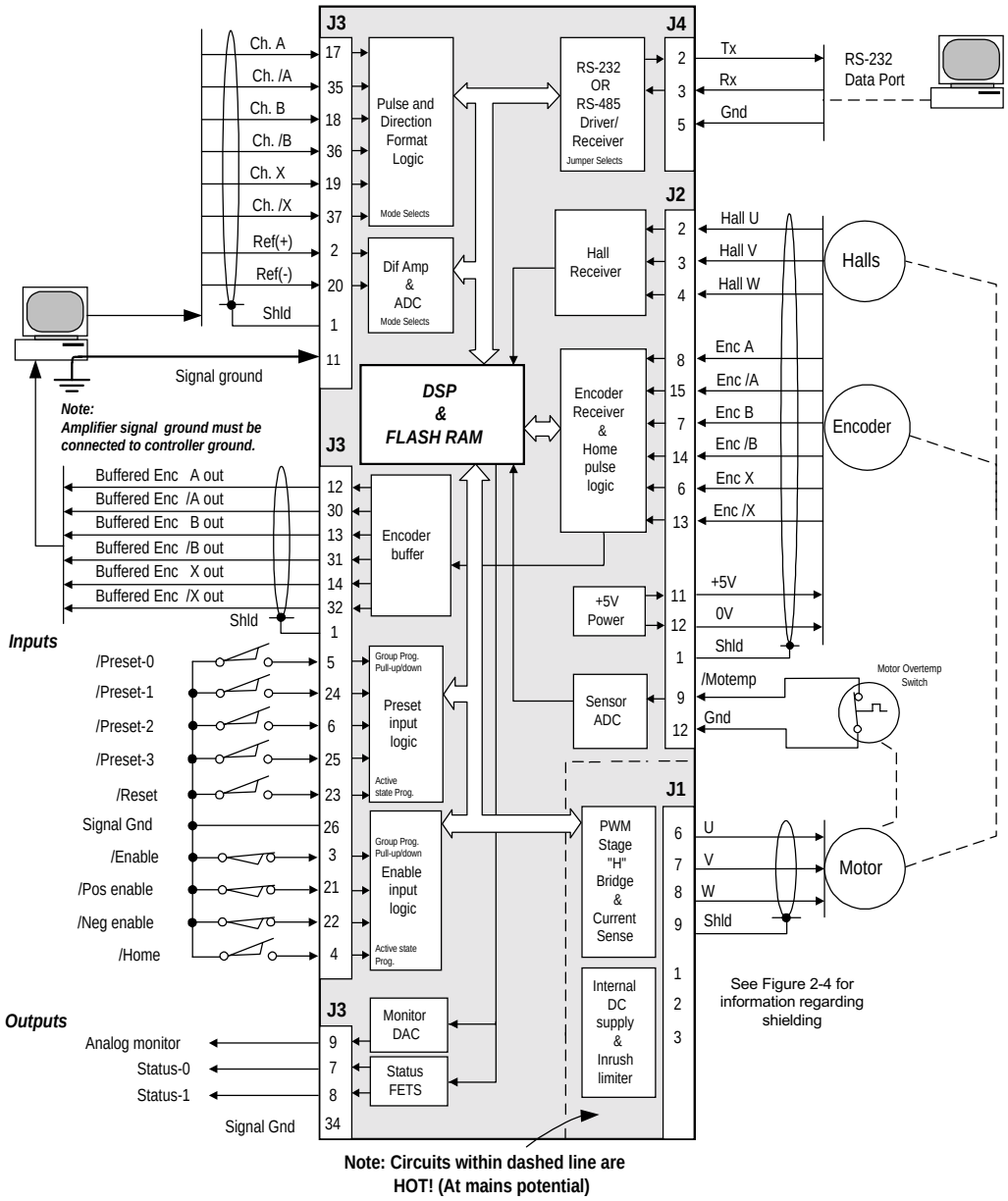


Figure 2-1 Functional Diagram Amplifier Connectors

Grounding

A single-point ‘star’ ground should be used with all device grounds converging. Do not ‘daisy-chain’ the connections to ground. The ground connections should be as short a distance as possible. The motor ground should be connected directly to the amplifier.

Safety Grounding

For safety, it is important that amplifier frame ground on J1 be connected to earth ground, typically through the power cable.

Note: Frame ground on AC models is at J1-3. Frame ground on DC models is at J1-1.

The connections on the power board, such as the motor phase, are at line potential.

Signal Grounding

The signal board is fully isolated from the power section in this series of amplifiers. For proper operation, ***connect the signal ground on J3 to the controller ground.***

Chassis & Cable Shield Grounding for EMI Reduction & CE

To minimize noise radiation from the motor and power cabling, wires should be twisted and shielded. Motor sensor signals are often routed near the motor phase winding cables. To minimize coupling of PWM noise, sensor signal wiring should be multiple-conductor-shielded cable. Further more, all cable shields should be case grounded at both ends for compliance with CE emissions limits. *See Figure(s) 2-1 through 2-4 for details.*

AC & DC Power & Motor Phase (J1)

Power supply and motor connections (Figure 2-2) should be made with wire that has a rating to support the amplifiers continuous current. AWG 14 wire supports all amplifiers in this series. Additional recommendations: use wire insulation with a voltage rating of 600V DC and a temperature range of 105°C.

Voltage & Current Ratings of Mains

The mains for high voltage units that use 240V AC, 50/60Hz, 1 phase, should be rated for a current of 20 amps. The mains for low voltage units that use 120V AC, 50/60Hz, 1 phase, should be rated for a current of 20 amps.

Fusing

Model	7228AC	7228DC	7428AC	7428DC
Fuse	120V@20A	120V@20A	250V@20A	230V@20A

Fusing should be time delayed and installed on any hot lines coming from the mains. For **low** voltage units, *install the fuse on the hot line*. For **high** voltage units, *install fuses on both hot lines*.

Line Filters for EMI Reduction & CE

A line filter, such as the Corcom P/N20VDK6, must be installed no more than three feet from the amplifier's power entry terminal strip for compliance with CE emissions limits.

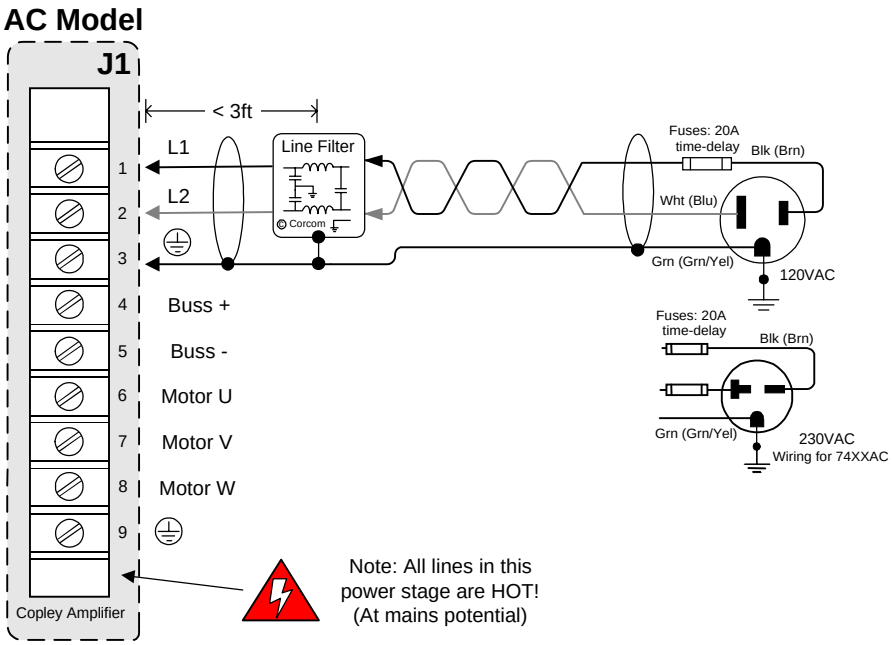


Figure 2-2 AC Model J1 Connector

Pin	Signal	Function
1	L1	AC Power Input Hot (black or brown wire from AC mains)
2	L2	AC Power Input Neutral (white or blue wire from AC mains)
3	GND	Chassis safety ground (green or green/yel wire from AC mains)
4	Buss (+)	Positive terminal of internal DC power supply
5	Buss (-)	Negative terminal of internal DC power supply
6	Motor U	Amplifier output to “U” winding of motor
7	Motor V	Amplifier output to “V” winding of motor
8	Motor W	Amplifier output to “W” winding of motor
9	GND	Chassis safety ground. Also for cable shield of motor cable.

Table 2-1 AC Model J1 Pin(s) Description

DC Model Power Connections

No Transformer Required! This model operates from power supplies that rectify the line directly with full optical isolation between signal and power stages.

Voltage & Current Ratings of Power Supplies

The power supply should deliver sufficient power **P**, to supply the power delivered to the motor, and the power lost in the amplifier.

In general, the supply voltage **V** should be larger than the motor's nominal voltage rating for the absolute maximum voltage rating. Consult the motor manufacturer for more information.

The current delivered by the supply can be calculated from the equation **I = P / V.** Furthermore, the power supply should be able to handle any current surge that occurs during power up. The Copley amplifier limits the current surge to 37 Amps maximum on power-up.

External Capacitance Required

The capacitor used in the bridge rectifier circuit must be able to keep the voltage ripple, or **Vrip**, at sufficient levels and the capability of storing 10 times the energy regenerated from the load. The capacitor **C** may be calculated from this equation:

$$C = I / (120Hz * Vrip)$$

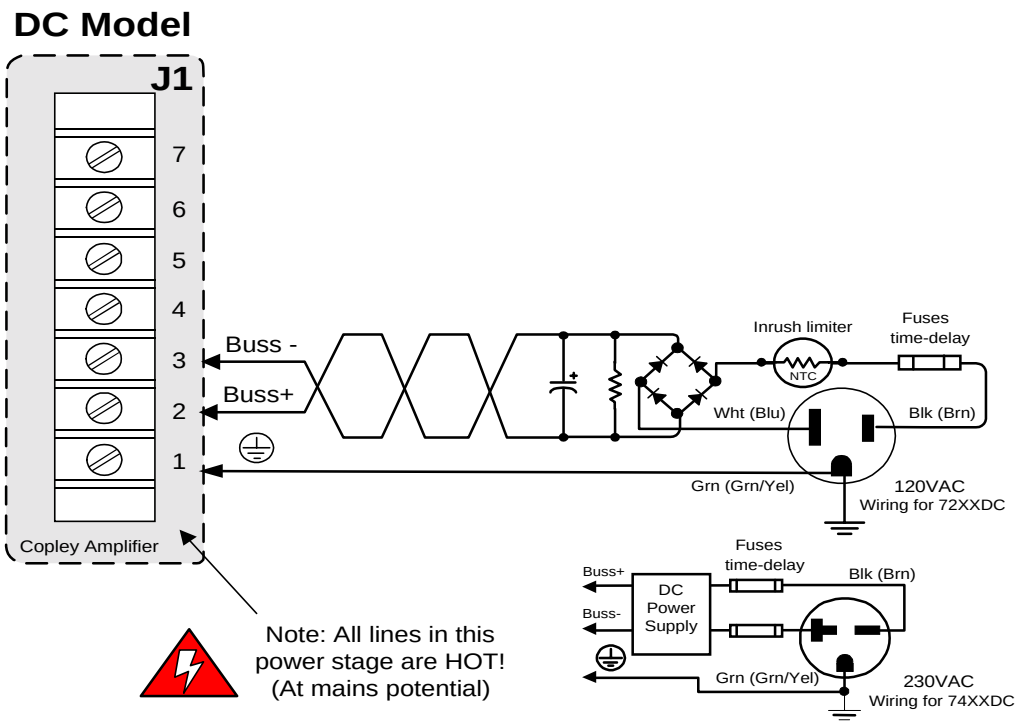


Figure 2-3 DC Model J1 Connector

Note: Circuits shown are typical connections and are not for design purposes.

Pin	Signal	Function
1	GND	Chassis safety ground (green or green/yel wire from AC mains)
2	Buss (+)	DC power input positive terminal from DC power supply
3	Buss (-)	DC power input negative terminal from DC power supply
4	Motor U	Amplifier output to "U" winding of motor
5	Motor V	Amplifier output to "V" winding of motor
6	Motor W	Amplifier output to "W" winding of motor
7	GND	Chassis safety ground. Also for cable shield of motor cable.

Table 2-2 DC Model J2 Pin(s) Description

Motor Phase Wiring Connections

Motor Protection: Fusing & Circuit Breakers

To protect the motor, during the prototype phase, it is the recommendation of Copley Controls Corp. to use time delayed fusing in line with the motor. To protect the motor from an unintentional event the current rating should be no greater than the motors continuous stall current.

Shielding

To minimize noise radiation from the motor cabling, wires should be twisted and shielded. Furthermore, all cable shields should be case grounded at both ends for compliance with CE emissions limits.

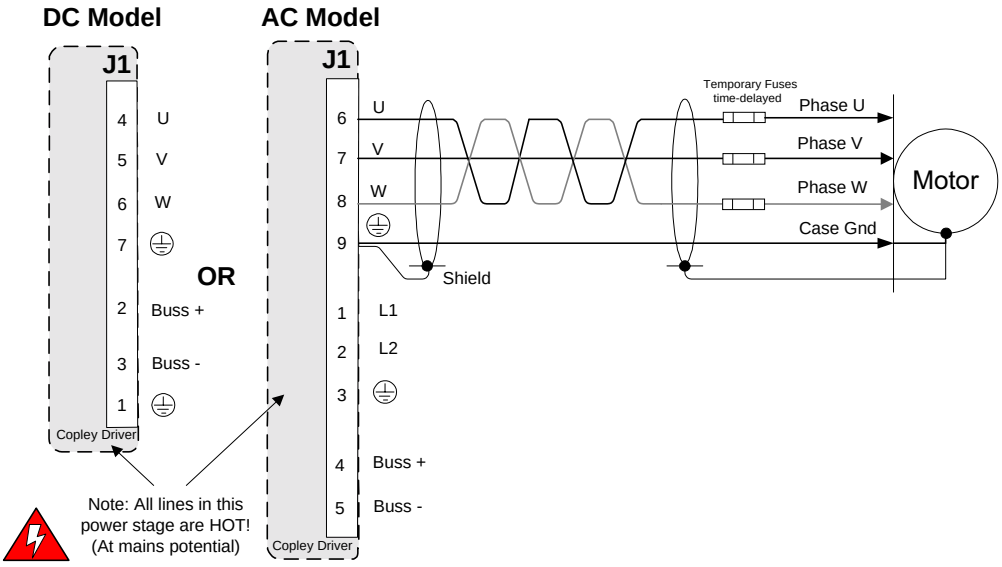


Figure 2-4 Motor Phase Wiring

Note: Circuits shown are typical connections and are not for design purposes.

Motor Signal Connector (J2)

Connectors & Cabling

Motor signal connections should be made with wire that has a rating to support the signal current. AWG 24 wire will support all motor signals in this series. Additional recommendations for wire insulation are for a voltage rating of 300 V DC and a temperature range of 80°C. To minimize coupling of PWM noise, encoder signal wiring should be multiple-conductor twisted-pair shielded cable. Furthermore, all cable shields should be case grounded at both ends for compliance with CE emissions limits.

Pin	Signal	Function
1	Safety GND	Chassis ground. Not connected to internal signal ground.
2	Hall U	Digital Hall inputs for "U"
3	Hall V	Digital Hall inputs for "V"
4	Hall W	Digital Hall inputs for "W"
5		Reserved
6	Enc Ch. X	Encoder Channel X
7	Enc Ch. B	Encoder Channel B
8	Enc Ch. A	Encoder Channel A
9	Motemp	Motor teperature sensor
10	N.C.	No connection
11	+5V @ 250mA.	DC power for encoders and Halls (Note 1)
12	0V.	Signal ground for +5V and Halls.
13	Enc Ch. /X	Encoder Channel /X
14	Enc Ch. /B	Encoder Channel /B
15	Enc Ch. /A	Encoder Channel /A

Table 2-3 J2 Hall and encoder Connections

Note 1: +5VDC @ 250mA also connects to J3-15, J3-27 and J2-11. Combined **not** to exceed 250mA.

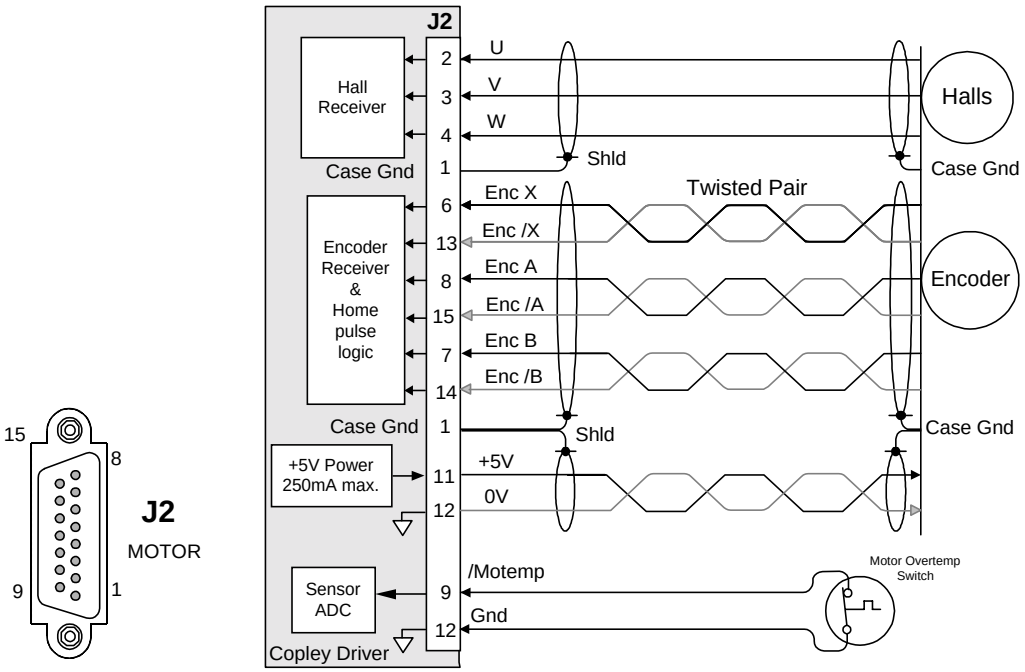


Figure 2-5 J2 Signal Connector

The J2 connector is a female Sub-D, 15 position with #4-40 standoffs for the cable shell.

More About Encoder and Hall Sensor Connections

Encoder Sensor

Quadrature encoders typically provide three signals (Figure 2-6): two square waves (phase A and B) that are 90° apart, and an index pulse, which will typically occur once per revolution.

There are several ways to configure the encoder interface. However, differential signals are recommended for their inherently large CMRR (common mode noise rejection ratio). *For more information about encoder formats see Chapter 3.*

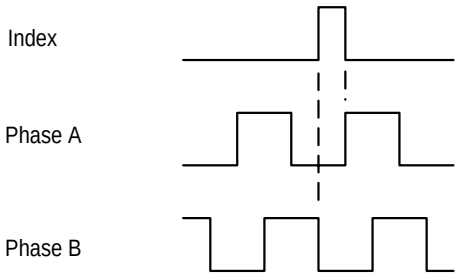


Figure 2-6 Quadrature Encoder Pulses

Encoder Receiver

The same encoder receiver circuit (Figure 2-7) is used to receive the quadrature encoder pulses: phase A, phase B, and index. This circuit is designed to work with differential signals (Figure 2-8), single-ended TTL signals and open collector circuits (Figure 2-9).

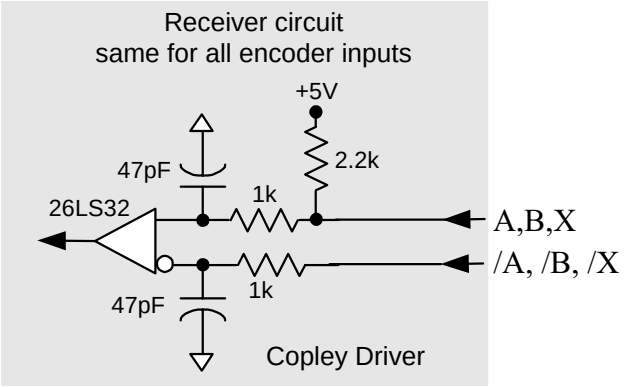


Figure 2-7 Encoder Receiver Circuirt

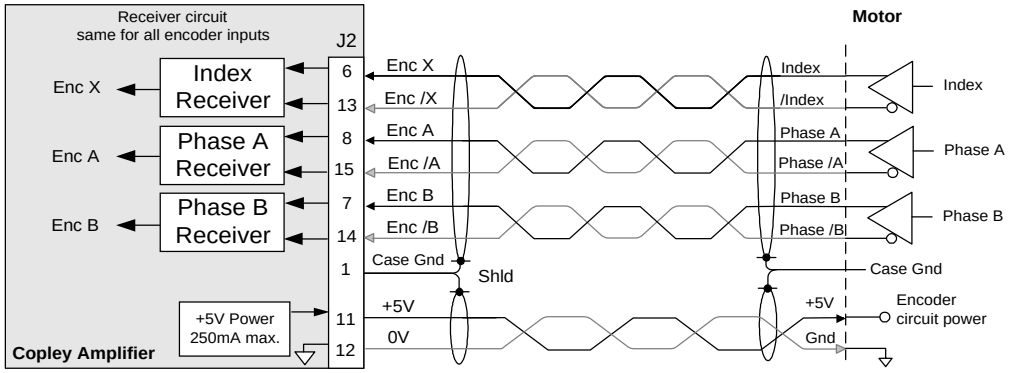


Figure 2-8 Quadrature Encoder, Differential Configuration

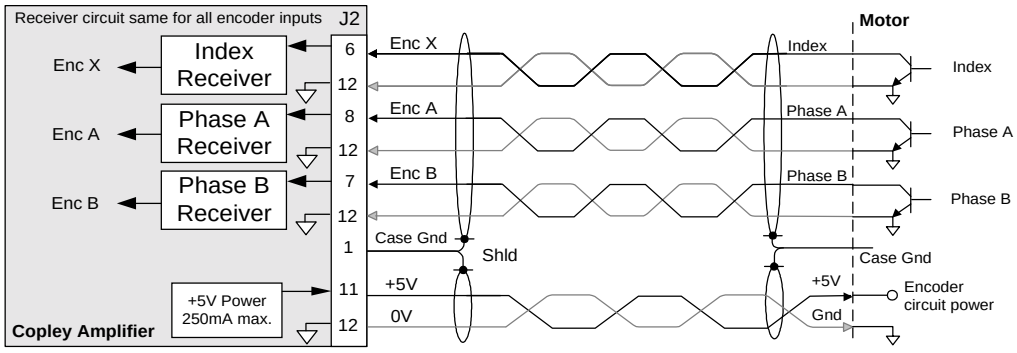


Figure 2-9 Quadrature Encoder, Single-ended Open Collector

Hall Sensors

The controller performs a phase initialization routine, using the encoder for proper commutation. However, improved phase initialization can be achieved using Hall sensors to determine initial positioning. Typical Hall signals are shown in Figure 2-10.

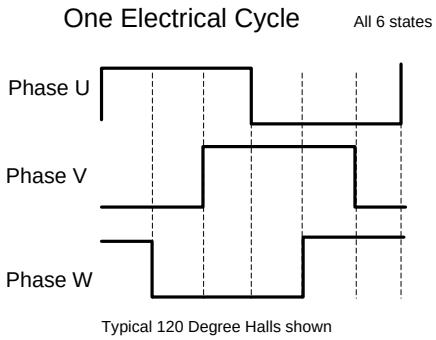


Figure 2-10 Hall Signals

Hall Input Circuit

The same Hall input circuit (Figure 2-11) is used to receive Hall signals: phase U, phase V, and phase W. The circuit is designed to work with single-ended TTL signals and single-ended open-collector signals.

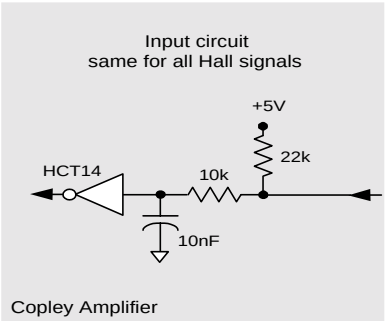


Figure 2-11 Hall Input Circuit

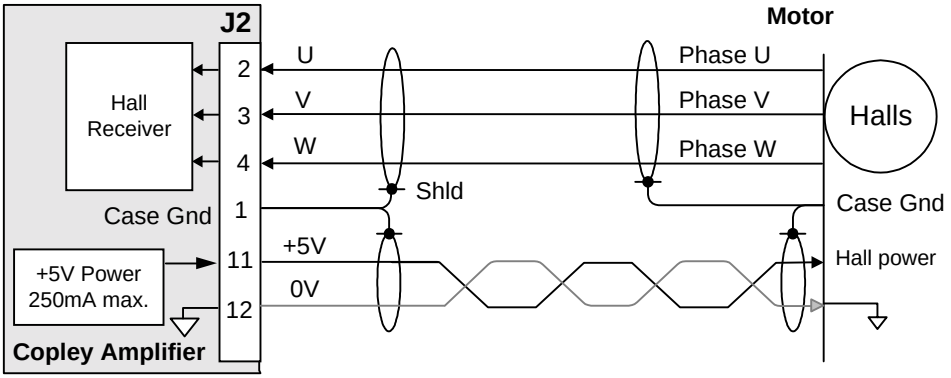


Figure 2-12 Hall Connections

Temperature Sensor Input Circuit

The temperature sensor input circuit (Figure 2-13) receives signals from sensing devices, such as thermal sensors. The circuit works with resistive sensors, or an open/closed switch to ground.

The 7XX8Series work well with N.O. (Normally Open), N.C. (Normally Closed), or resistive sensors. The overtemp threshold(s) are adjustable with CME and may be stored as part of a preset.

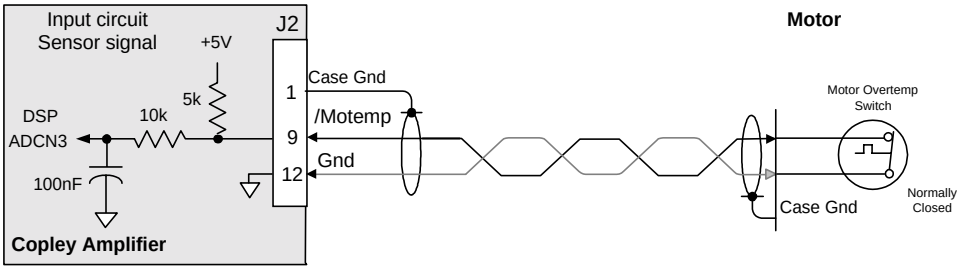


Figure 2-13 Temperature Sensor Input Circuit

Signal Connector (J3)

Control signal connections should be made with *wire that has a rating to support the current signal.* AWG 24 wire will support all motor signals in this series. Additional recommendations are for a voltage rating of 300 V DC and a temperature range of 80° C. To minimize coupling of PWM noise, sensor signal wiring should be multiple-conductor twisted-pair shielded cable. Further more, all shielded cables should be case grounded at both ends for compliance with CE emissions limits.

Pin	Signal	Function	Pin	Signal	Function
1	Safety GND	Chassis/frame ground.			
2	Ref (+)	+/-10V analog command input	20	Ref (-)	+/-10V analog command input
3	/Enable input *	Amplifier enable	21	/Pos Enable *	Positive direction enable
4	/Home *	Home switch input	22	/Neg Enable *	Negative direction enable
5	/Preset-0 *	1 of 4 preset mode select lines	23	/Reset *	Amplifier fault reset input
6	/Preset-2 *	1 of 4 preset mode select lines	24	/Preset-1 *	1 of 4 preset mode select lines
7	Status-0 Out	Amplifier status output #1	25	/Preset-3 *	1 of 4 preset mode select lines
8	Status-1 Out	Amplifier status output #2	26	0V Sgnd	Signal Ground
9	Analog Mon	Programmable monitor output	27	+5V Output	+5VDC @ 250mA output
10	Curr Limit	External current-limit input	28	+12V Output	+12VDC @ 25mA output
11	0V Sgnd	Signal Ground	29	-12V Output	-12VDC @ 25mA output
12	Ch. A out	Buffered encoder output Ch A	30	Ch. /A out	Buffered encoder output Ch /A
13	Ch. B out	Buffered encoder output Ch B	31	Ch. /B out	Buffered encoder output Ch /B
14	Ch. X out	Buffered encoder output Ch X	32	Ch. /X out	Buffered encoder output Ch /X
15	+5V Output	+5VDC @ 250mA	33	Ch. A	Encoder input Chan. A
16	N.C.	No connection	34	0V Sig Gnd.	Signal Ground
17	Ch. A in	Encoder input Chan. A	35	Ch. /A in	Encoder input Chan. /A
18	Ch. B in	Encoder input Chan. B	36	Ch. /B in	Encoder input Chan. /B
19	Ch. X in	Encoder input Chan. X	37	Ch. /X in	Encoder input Chan. /X

Table 2-4 Signal Connections J3

Note: +5VDC @ 250 mA connects to J3-15, J3-27 and J2-11. Combined current from all pins must **not** exceed 250mA.

* Pull-up to +5V, or pull-down to GND are selectable and may be stored in a preset. In addition, the active level (Hi or Lo) may also be selected and store as a preset.

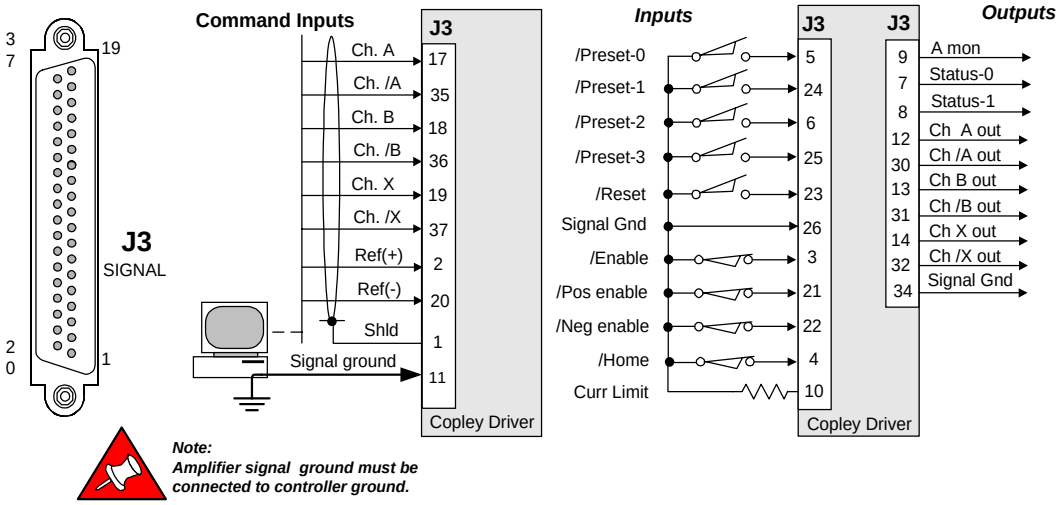


Figure 2-15 J3 Connector and Cabling

The J3 connector is a female Sub-D, 37-position with #4-40 standoffs for cable shells.

Analog Command Inputs (±10V)

The analog input circuit (Figure 2-16) receives analog torque or velocity commands from the controller in the range of ± 10V. The differential configuration reduces common mode noise.

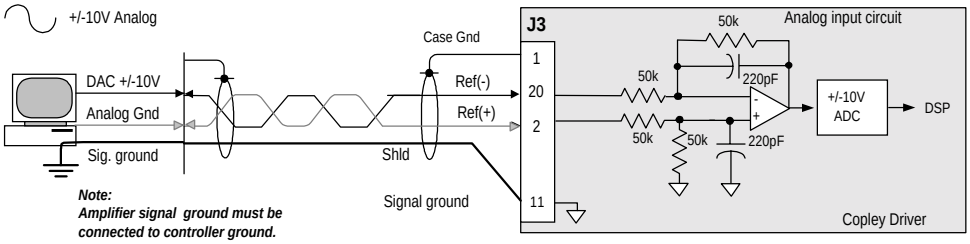


Figure 2-16 Connections to a Controller

Digital Command Inputs

Digital input commands, the same use with stepper motors, can be used to command position. See the waveforms (Figure 2-17). Electronic gearing can be used to ratio the input command.

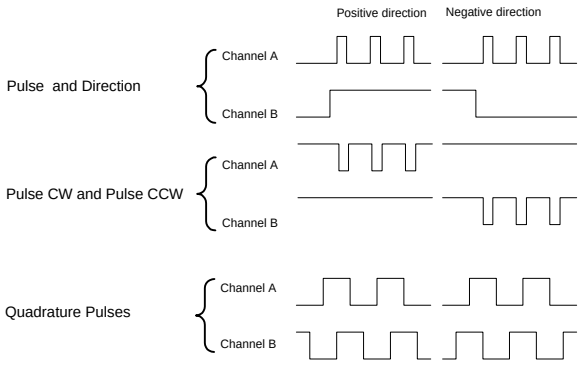


Figure 2-17 Digital Command Inputs

Digital Command Receiver

The Digital command receiver (Figure 2-19) receives the Channel A, Channel B and Channel X inputs. The circuit works with differential signals, single-ended TTL signals and single-ended open collector signals.

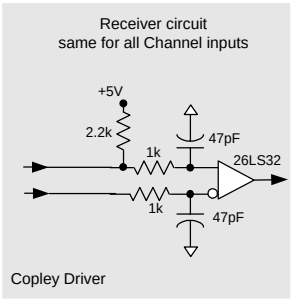


Figure 2-18 Digital Command Receiver

Digital Remote Connections

The next several figures illustrate possible configurations to a remote computer (controller).

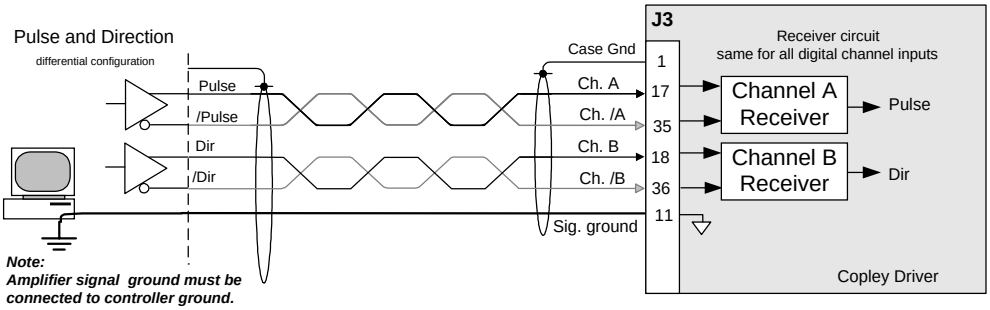


Figure 2-19 Differential Pulse and Direction Configuration

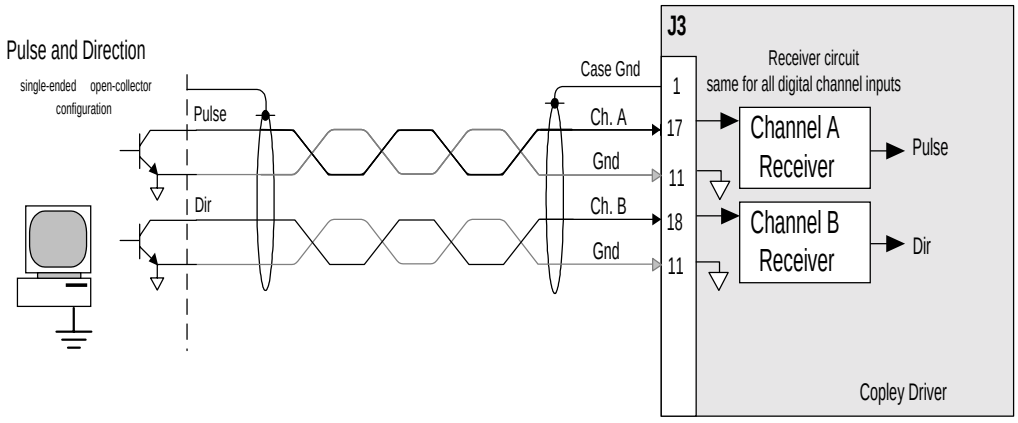


Figure 2-20 Single-Ended Open-Collector Pulse andDirection Configuration

The single-ended configuration is most susceptible to noise and therefore is the least desirable.

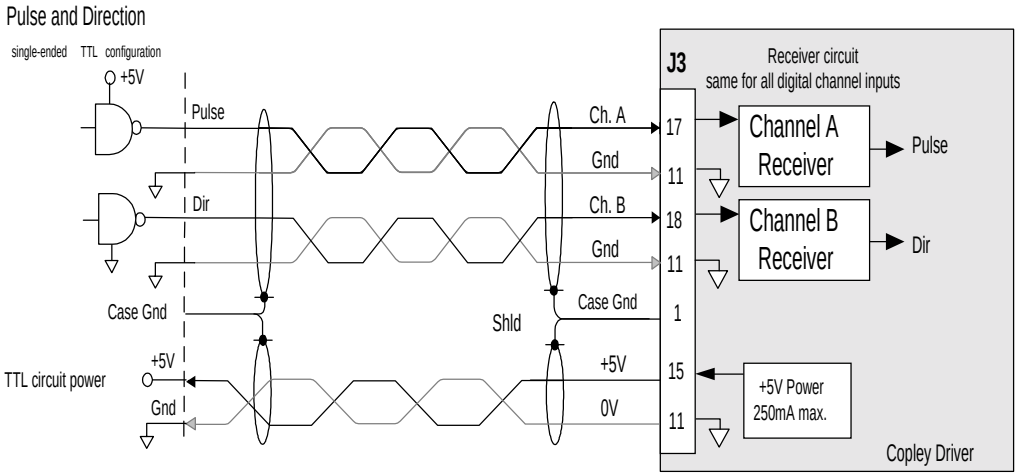


Figure 2-21 Single-Ended TTL Pulse and Direction Configuration

The single-ended configuration is most susceptible to noise and therefore is the least desirable.

Master Encoder Inputs

The master encoder input receives encoder pulses phase A, phase B, and index. This circuit is designed to work with differential signals, single-ended TTL signals, and single-ended open collector signals. Software supports the master encoder to perform position commands. Electronic gearing can be used to ratio the master encoder command.

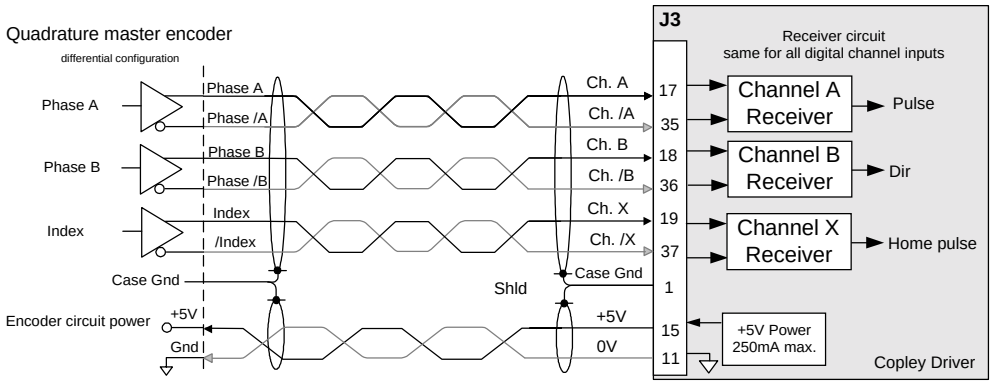


Figure 2-22 Differential Master Encoder Connections

Current Limit Input

The current limit can be controlled externally, via connector pin J3-10 (Figure 2-23). A resistor can be connected between this pin and signal ground (J3-11, 26, or 34), or the pin can be driven by a voltage between 0 and +10VDC. Using this technique, the current limit can be controlled over a range of 100% to 0% of the peak.

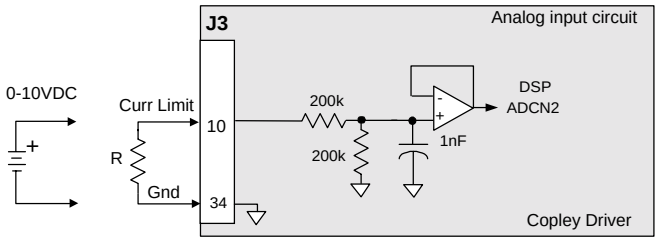


Figure 2-23 Current Limit Input

Note: The values above are within 10%, typically. For greater accuracy, measure current monitor and select parts for exact limit value.

Amp-Enable, Limit and Home Switch Inputs

Amp Enable Input

The /Enable input functions as an on/off switch for the drive. When activated the drive functions normally. When deactivated, the output stages are disabled. If the motor is turning, and no brake is engaged, the motor will coast to a stop. The state of the Status LED is also affected by the /Enable input. If it is activated, and there are no faults, then the LED will be green. Deactivating the /Enable will cause the LED to flash green. The active level and open circuit state, of the enable lines, can be software configured in the Amp Setup screen.

Travel-limit Inputs (Pos/Neg Enables)

These inputs are typically used with end of travel limit switches. When a /PosEnable or /NegEnable are activated the amplifier inhibits further driving into a travel limit, but still enables the amplifier to back out. Since motion in one direction is permitted, changing the state of these inputs has no effect on the status LED.

Home Switch Input

The /Home input is used to detect the ‘home’ position.

Enable, Limit and Home Input Circuit

The Enable, Limit and Home input circuit (Figure 2-23) is used to receive the Enable signals: /Enable, /Pos Enable, /Neg Enable, and /Home. For ‘fail-safe’ operation, such as a disconnected or wire broken, a software command controls the Enable and Home inputs, pull-up or pull-down level, as a group. This circuit is designed to work with single-ended TTL signals, single-ended open-collector signals, and PLC’s that switch to +24V max. or ground.

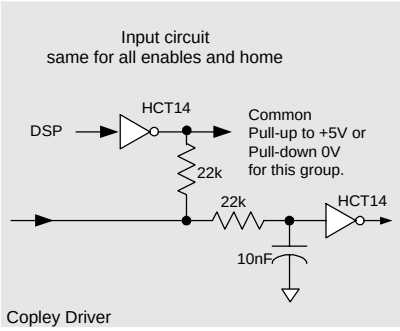


Figure 2-23 Enable, Limit, Home Input Circuit

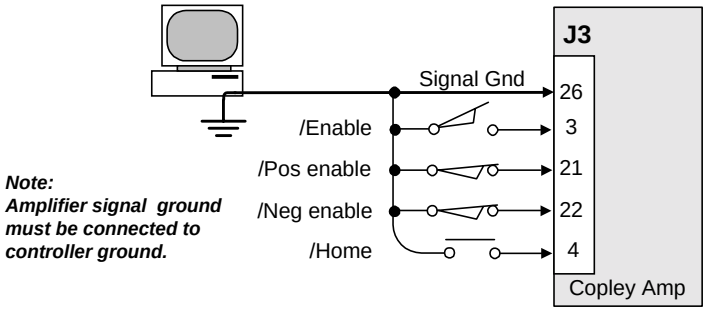


Figure 2-24 Enable Configuration

Reset Inputs

The /Reset input can be used to clear a fault condition caused by over temperature, or output short circuit. The /Reset line should be activated after the fault is removed. In the case of over temperature fault, the amplifier can be re-enabled after the case temperature cools to <70°C. In the case of a short circuit, the drive can be re-enabled every 50ms and will be shutdown as long as the short remains.

Digital Preset and Reset Inputs

You can use the four Preset inputs to initiate 16 predefined velocity, torque or motion profiles.

Preset and Reset Input Circuit

This group consists of the Preset signals /Preset 1, /Preset 2, /Preset 3, /Preset 4 and /Reset. For 'fail-safe' operation, such as a disconnected or wire broken, a software command controls the Preset and Reset inputs, pull-up or pull-down level, as a group. This circuit (Figure 2-25) works with single-ended TTL signals, and single-ended open-collector signals.

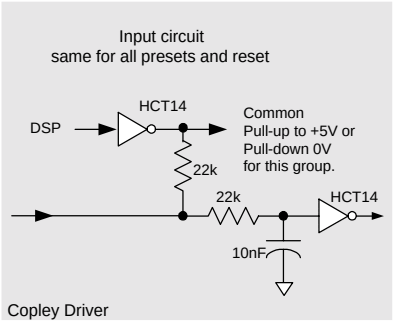
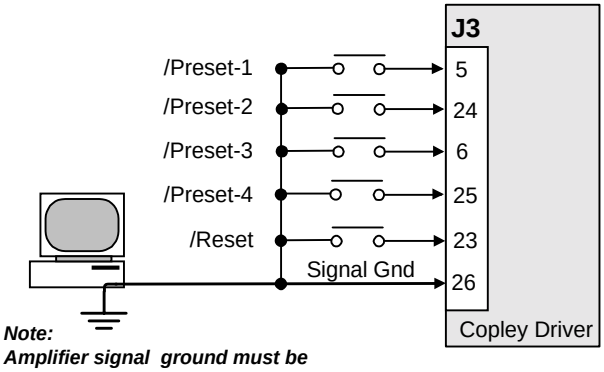


Figure 2-25 Preset and Reset Input Circuit

Connections to a Remote Computer



Note:
Amplifier signal ground must be connected to controller ground.

Figure 2-26 Connections to a Remote Computer (with Pull-ups at +5 V)

Status Outputs

There are two status outputs that are used to indicate amplifier status or fault conditions. The outputs are N-channel MOSFET with 10k Ohms pull-up resistors to +5VDC. The specifications are:

- Maximum off-voltage = 50VDC
- Maximum sink current = 250mA
- On resistance = 5 ohms

The status outputs can be used to drive a relay, opto-coupler, or PLC input. See Figure 2-27, which contains a relay and optocoupler configuration, with and external +24VDC supply.

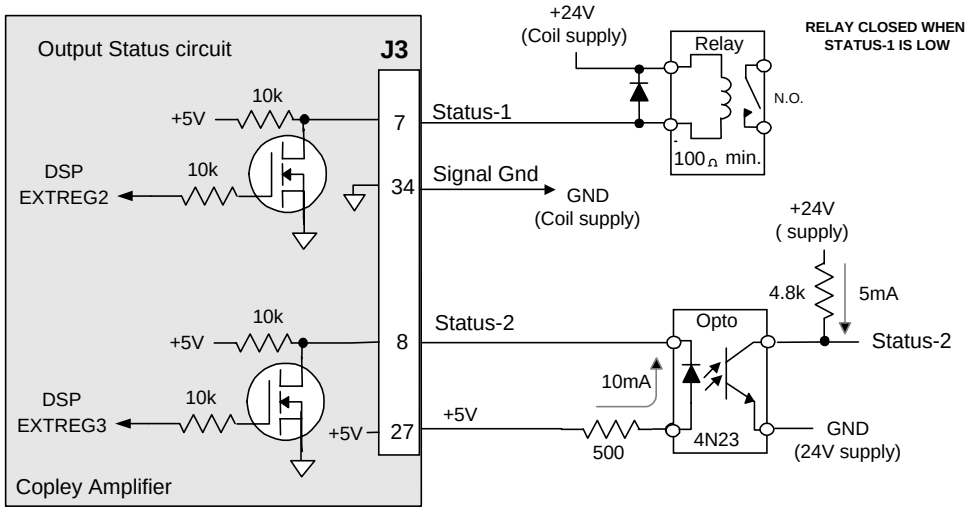


Figure 2-27 Status Outputs

Analog Monitor Output

The analog monitor output (Figure 2-28) is a +/-10V signal that can be used to monitor analog conditions measured inside the amplifier. The output can be software configured to produce a voltage proportional to: phase current in a motor winding, motor velocity, or other parameters.

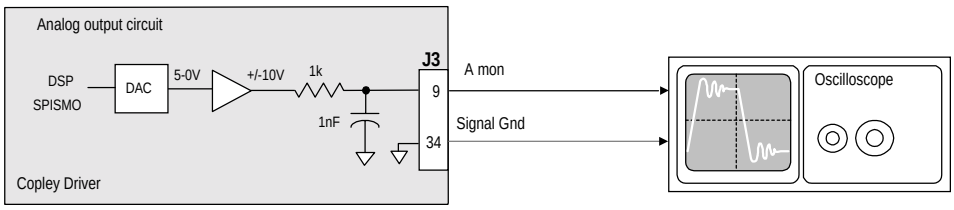


Figure 2-28 Analog Monitor Output

Data Connector (J4)

The DSP Model 7XX8 supports RS-232 Jumpers on the amplifier's signal module set the configuration for the protocol. Data connections should be made with wire that has a rating to support the signal current. AWG 24 wire will support all data signals in this series. Ribbon cable is acceptable for short distances and baud rates less than 9600 however, to minimize coupling of PWM noise, data signal wiring should be multiple-conductor twisted-pair shielded cable. The amplifier looks like DCE (Data Communications Equipment) and does not require a “null-modem” cable.

RS-232 Communications Mode

RS-232 communications mode is the default. The default settings for the communications port are 9600 baud, eight data bits, no parity, 1 stop bit, no flow control.

Pin	Signal	Function
1	-	-
2	TxD	RS-232 Serial Data Output (Amp —> Controller)
3	RxD	RS-232 Serial Data Input (Controller —> Amp)
4	-	-
5	Gnd	Ground

Table 2-5 RS-232 Connector Pin-Out

RS-232 Cable and Connector

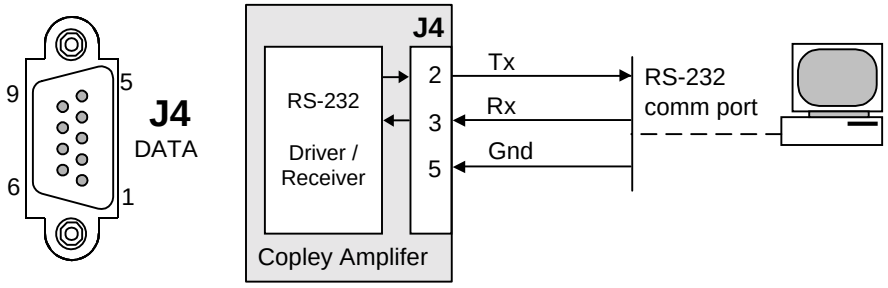


Figure 2-29 Data Connector J4

Connector type: 9-pin Sub-D, female. #4-40 locking standoffs for connector cable clamps.

Notes: 1. Signals in ***Bold & Italics*** are for standard, 3-wire RS-232 connection.
2. Do **not** use ribbon cable for connection to multiple amplifiers when operating amplifier in RS-232 mode.

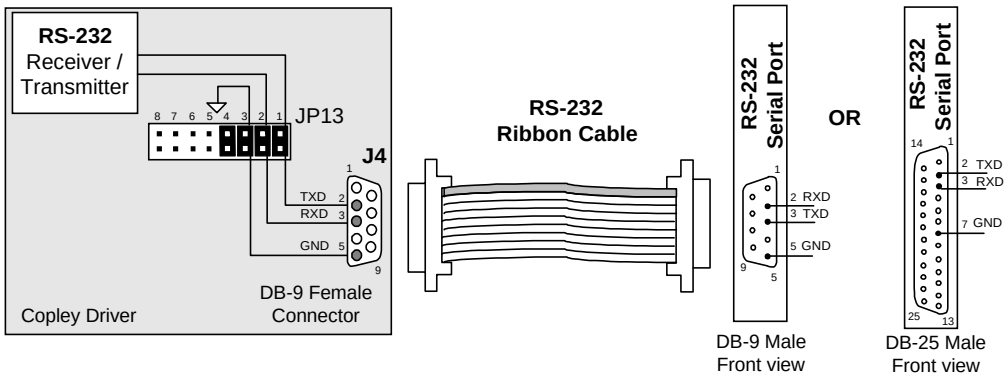


Figure 2-30 RS-232 Cable and Connnector

NOTES

Amplifier Status Indicator

The **Amplifier Status** indicator is an LED that, depending on color, reflects operating conditions (Table 2-7).

Color	Condition	Action Required to Enable
Flashing Green	Ready	Enable amplifier (J3-3) (Note 1).
Green	Normal	None. Normal "Run" condition.
Red	Power Fault	Bring AC voltage into range.
Flashing Red	Latching Fault	Ground /Reset input, or cycle AC power OFF/ON.

Table 2-7 Amplifier Status Indicator

Note 1:
Fault = Output short circuit or heatplate overtemperature. Amplifier 'latches' off and stays off until reset.
Amp OK = Internal buss voltage is within limits AND NOT-Fault
Ready = Amp OK AND NOT-enabled
Normal = Amp OK AND enabled

Signal Module

This section illustrates the amplifier's signal module layout (Figure 2-32) and jumper settings (Figure 2-33).

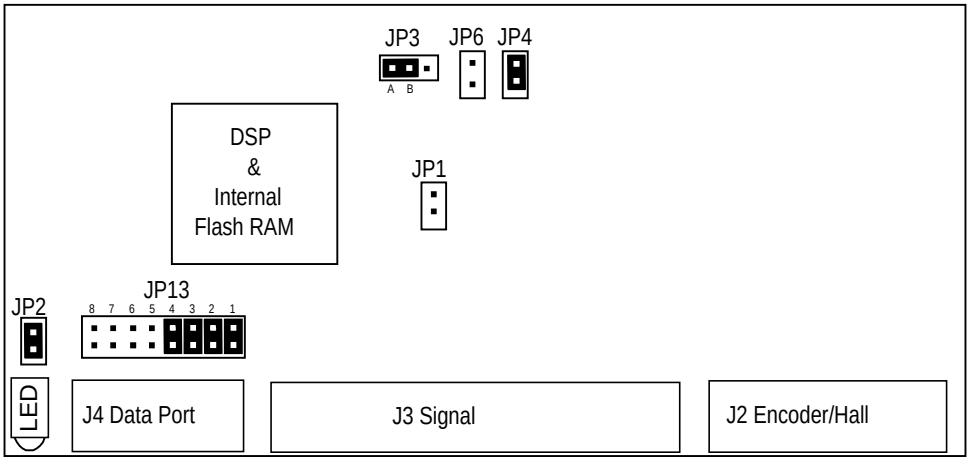


Figure 2-32 Signal Module Layout

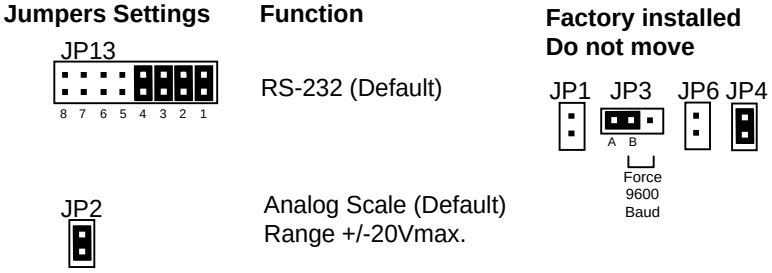


Figure 2-33 Signal Module Jumper Settings

Chapter 3 Getting Started

This chapter introduces you to the ***Copley Motion Explorer™*** software (CME). In conjunction with **CME** screens there are step-by-step procedures enabling you to *install a Copley supplied motor* or *your own motor.*

In this chapter there are procedures for several motor installation scenarios:

- *Installation Using a Copley Motion Explorer Development Kit*
- *Installation Using a Copley Motor Data File and a New Copley Motor*
- *Installation Using a Vendor Specification and Motor*

For detailed descriptions of the ***Copley Motion Explorer™*** screens, see Chapter 5.

Verifying Hardware Installation

Perform the following preliminary checks during all motor installations.

1. Make sure all connectors are properly secured (Figure A-3).

2. Make sure the **Status** indicator on the amplifier is flashing green while power applied.

3. On the pendant board (Figure B-1):

a. Make sure all the switches are *up*.

b. Make sure the Current Limit potentiometer is set fully clockwise.

c. Make sure the +/- 10 V potentiometer is set fully counter-clockwise.

Starting Copley Motion Explorer

1. In Windows, select **Start >Programs >Copley Motion Explorer >Copley Motion Explore**r.

2. The **Welcome** screen (Figure 3-1) displays. Select **On-Line** button by clicking on it.

3. The **On-Line Connection** screen (Figure 3-2) displays.

4. Select the **COMM** port that connects the PC to the amplifier.

5. Select the **Desired Baud** rate.

6. Select **Connect** button to establish communication with the amplifier.

A successful connection is indicated by the following:

- The **Amplifier Found** indicator turns green.
- The bar graph fills to indicate that the presets are uploading from the amplifier to the PC.
- The **Model number, Serial number** and **Firmware version** of the amplifier display.
- The **Status** indicator on the amplifier continues to flash green.

7. Selecting the **Continue** button should display the **Amplifier Status Now!** screen (Figure 3-3).

Copley Controls Corp.
Welcome to
Copley Motion Explorer
Version 1.2.16
Click the buttons below to select the way you want to work:
On-Line
OnLine: connected to an amplifier for programming and setup
Off-Line
Off-Line: for programming amplifiers, motors, or complete axes for downloading later
Dll Build Date : Apr 20 2000 15:54:15
Copyright (c) 1999, 2000 - Copley Controls Corporation
Exit

Figure 3-1 Welcome Screen

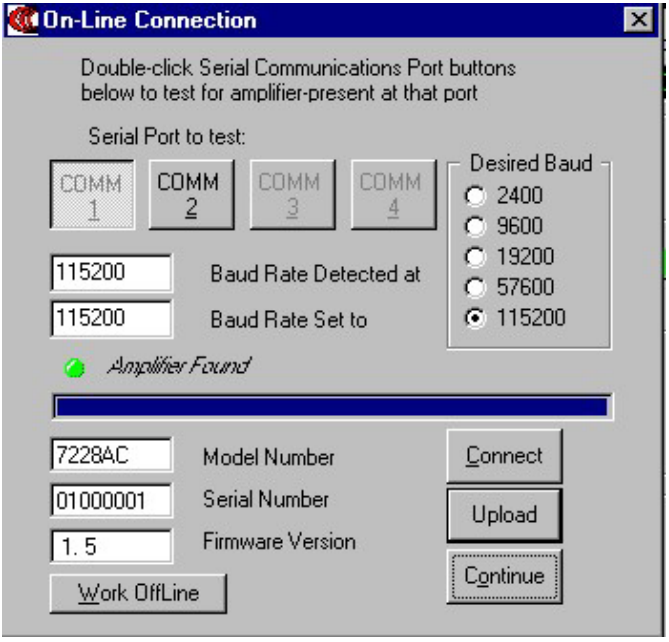


Figure 3-2 On-Line Connection Screen

The **Amplifier Status Now!** screen displays the status information most recently retrieved from the amplifier. You can check the **Status Updates** box to continuously update the **Amplifier status Now!** screen. This screen displays the amplifier's current preset, operating mode and motor data.

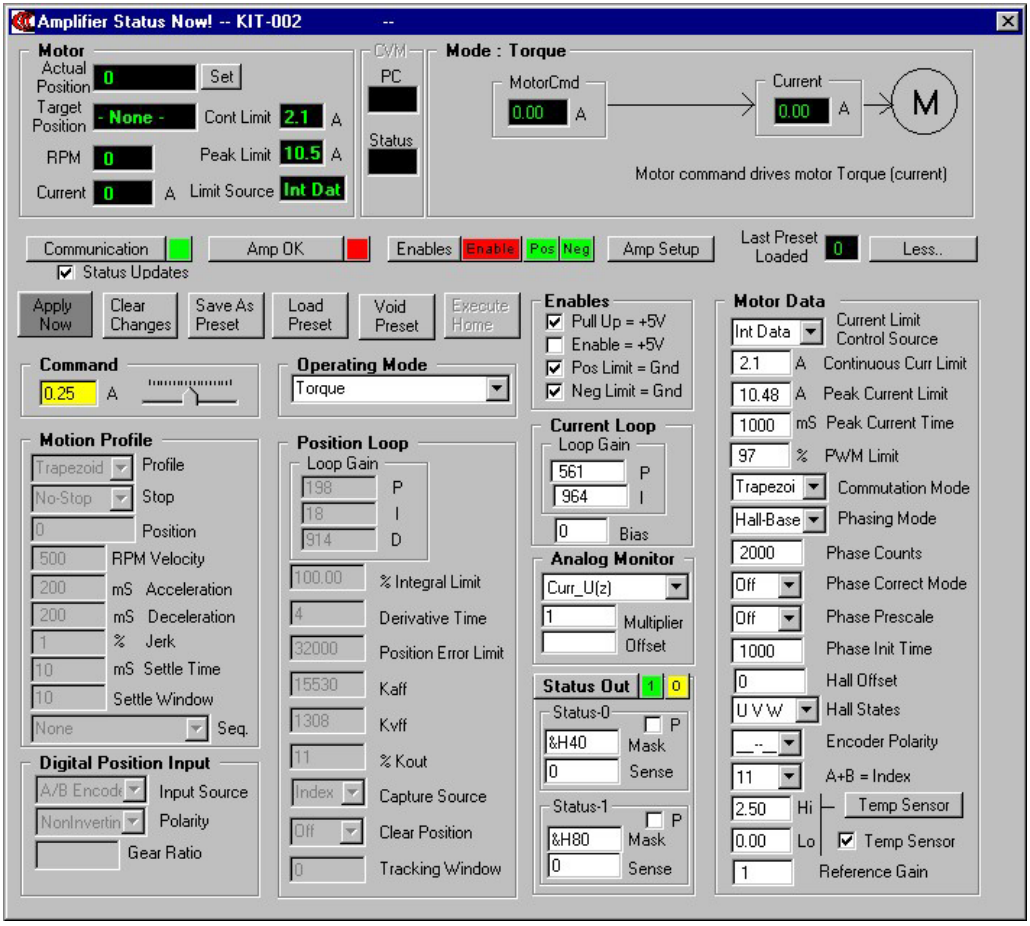


Figure 3-3 Amplifier Status Now! Screen

Installation Using a Copley Motion Explorer Development Kit Motor

Follow this procedure if you are installing a motor that accompanied a ***Copley Motion Explorer™*** Development Kit.

Verifying Software Parameters

Accompanying the ***Copley Motion Explorer™*** Development Kit, you received an Application Note. The note contains software parameters specific to the motor that shipped with the kit. These parameters include: **Operating mode, Enable, Motor Data, Current Loop, Position Loop** and **Motion Profile**.

1. On the **Amplifier Status Now!** screen, select **More** to display expanded software parameters.

2. Verify that the software parameters displayed on the **Amplifier Status Now!** screen are identical to the software parameters in the Application Note.

3. If the parameters match proceed to **First Move** in the next section.

Changing Software Parameters

You can change the settings in the **Amplifier Status Now!** screen.

1. Make changes as necessary in the **Amplifier Setup Now!** screen to match the Application Note. Changes will be highlighted in yellow.

2. Select **Apply Now** stores the changes in the amplifiers volatile memory.

3. Select **Save as Preset**. Select the desired preset number to save the parameters into flash memory on the amplifier.

Select **Void Preset** to delete the values in an amplifier preset. **Select Load Preset** to display a preset in the **Amplifier Status Now!** screen.

First Move

1. To verify that the motor is generating encoder pulses, rotate the motor shaft.

2. Observe the **Motor Actual Position** count change in the **Amplifier Status Now!** screen.

If the amplifier is using Hall-based phasing and the Halls are connected properly, then phase initialization is complete.

If you are *not* using Halls, see the section about *No Halls* under *Adjusting Calculated Motor Data* later in this chapter.

Enabling the Amplifier

1. On the pendant board, set the **Enable** switch to the down position. (This is the default fail safe mode; if the line is cut, the amplifier is disabled.)

2. Observe that the amplifier's **Status** indicator turns solid green.

Initiate a Move with the Pendant

1. Observe the **Amplifier Status Now!** screen. Make sure all the indicators — **Communications, Amp OK** and **Enable** — are green. (If they are not, see the section called ***Amplifier Status Now!*** screen in Chapter 5).

2. You can initiate a move by switching the desired preset on the pendant. (Refer to the Application Note that you received with the development kit.)

Homing Sequence

The Homing routine(s) can be used in conjunction with a preset to perform a predefined homing routine. You can access the **Homing Sequence** screen (Figure 3-4) from the **Tools** menu by selecting Homing.

Make Current Position Home

If you manually select a home position, select **Make Current Position Home** and **Apply** to download the home position to the amplifier. This is a medium accuracy routine that requires manual interface.

Home to Limit Switch

Using the preset velocity, the motor drives into the stop until the limit switch is hit. The motor is then backed off until the limit switch transitions back. The actual home position is dependant upon these switch characteristics. This is a medium to high accuracy routine, requiring no manual interface.

Home to Index Pulse

Using the preset velocity, the motor drives into the stop until the limit switch is hit. The motor is then backed off the limit, past the limit switch recovery, until the index pulse transition occurs. The actual home position is dependent upon the location of the index pulse. This is a very high accuracy routine that requires no manual intervention.

Custom

This is an optional routine, pre-programmed by Copley Controls, that you may execute from a Preset.

Figure 3-4 Homing Sequence

Software Parameter Notes

Here are some notes about software parameters. All of the software parameters are defined in Chapter 5.

Profiles

The **Profile** mode selections are: trapezoidal, S-curve, or velocity.

If you choose a sinusoidal S-curve, then you must set a **Jerk** value. (See the **Amplifier Status Now!** screen in Chapter 5.)

The **Velocity Profile** is actually a position loop that never gets to the destination.

If you do not enter a value for **Deceleration**, then the **Acceleration** value is used.

Position Loop Tuning

The position loop tuning parameters are determined by a mathematical model. They are initialized "soft" and with loading of the motor. For proper operation with a load, the PID values for the Position Loop may need to be changed. A tuning method follows:

Refer to Figure 3-4, which is a segment of the **Amplifier Status Now!** screen (Chapter 5).

1. Adjust the integral limit to 0 or set the integration term "I" to 0.

2. Increase the derivative term "D" for a sufficiently low position error.

3. Increase the proportional gain "P" for a sufficiently stiff position loop.

4. Increase the **Integration Limit** and integration term **"I"** to keep the torque at a sufficient value while under load.

The **Position Error Limit** is the number of encoder counts allowed before a position error occurs.

Kout is a multiplier at the end of the digital position loop, so it must not be set to zero.

See Chapter 5 for other position loop values.

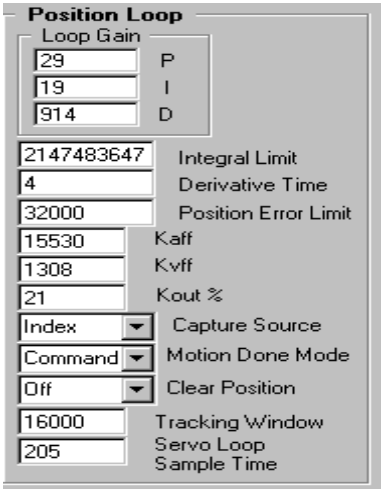


Figure 3-5 Position Loop Tuning

Trace

You can use the **Performance Trace** screen to tune the system, while the load is attached, by exciting a profile. On the **Main** menu, select **Tools > Trace** to display the **Performance Trace** screen. See the *Tools* section in Chapter 5 for details.

Status Output

You can use the Status Output feature to program

Stat-1 and **Stat-2** on the pendant to indicate motion profile active or an error condition has occurred. See the section called **Amplifier Status Now!** screen (Chapter 5).

Installation Using a Copley Motor Data File and a New Copley Motor

If you do not have a Copley Motion Explorer Kit, Copley can supply you with a Copley Controls motor (.ccm) data file. These files contain preliminary motor data. Save the file to your **Copley** folder in the ***Copley Motion Explorer*** directory.

Using a .ccm File

1. Perform *Verifying Hardware Installation* (p.3-1).

2. Perform ***Starting Copley Motion Explorer*** (p. 3-3).

3. On the **Main** menu, **Select File > Open** to display the **Open Publication** screen (Figure 3-5).

4. Select **File Type, .ccm.** to display a list of .ccm files in the folder.

5. Open the .ccm file. The **Motor Data > Specification** screen displays (Figure 3-6). The data can be viewed by selecting the appropriate tab.

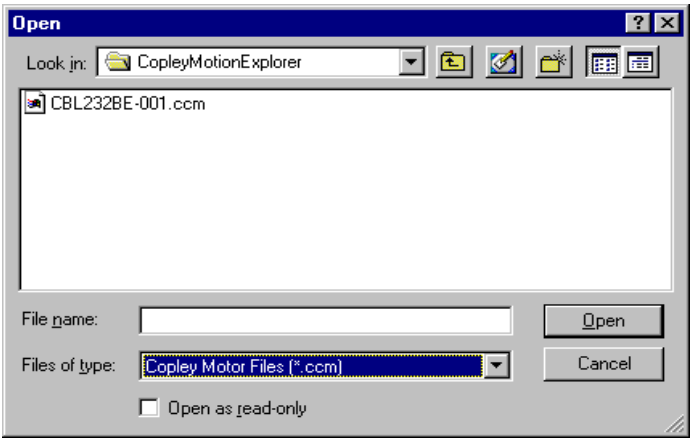


Figure 3-6 Open Publication Screen

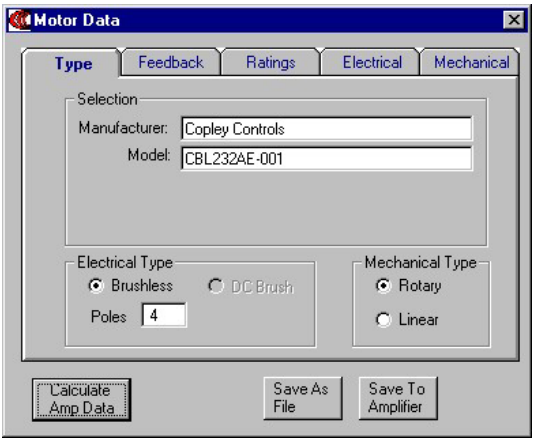


Figure 3-7 Motor Data Specification Screen

6. Select **Calculate Amp Data**. Copley Motion Explorer models the data in the file, calculates new data and displays it in the **Apply Motor Data** screen (Figure 3-8). You may make adjustments to data in this screen as necessary. See the section later in this chapter called *Adjusting Calculated Motor Data*.

7. Select **Save As File,** if you'd like to save the calculated data to your PC as a .ccm file.

Select Save to Amp, if you'd like to save the data to the amplifier.

8. Select **Apply to Amp.** The **Amplifier Status! Now!** screen displays.

9. Select **More.** The data modeled from the .ccm file is now associated with the appropriate amplifier and motor parameters on the **Amplifier Status Now**! screen.

10. Select **Save As Preset** if you want to save the data in the **Amplifier Status Now!** screen to the flash memory on the amplifier.

11. After saving data as a preset, you can select **File > Save As** (at the **Main** menu) to save the data as a .cca file.

12. Proceed to the section called *Adjusting Calculated Motor Data*.

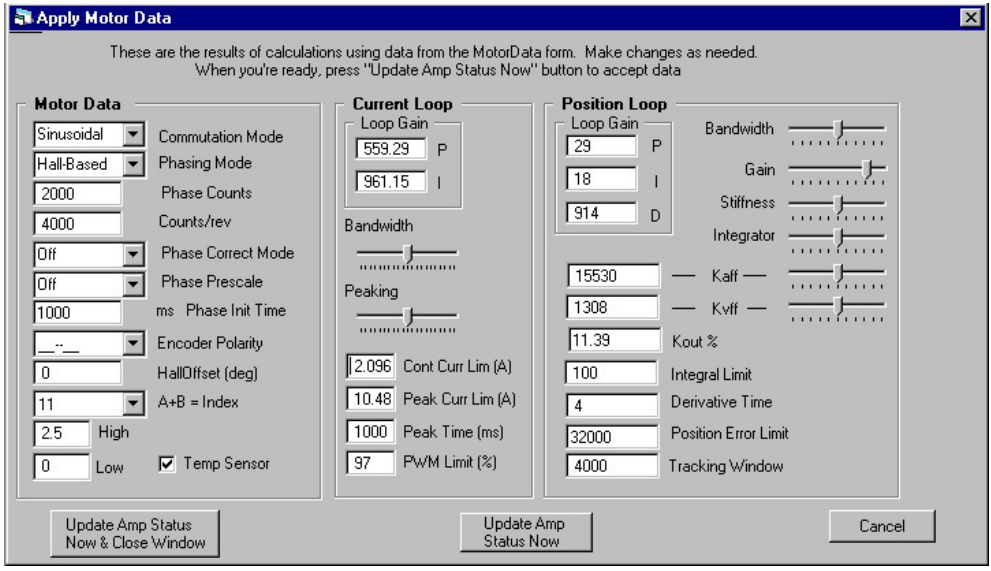


Figure 3-8 Apply Motor Data Screen

NOTES

Installation Using a Vendor Specification and Motor

If you are using a vendor specification to install a new motor follow the instructions below.

Using a Motor Specification

1. Perform *Verifying Hardware Installation* (p.3-1).

2. Perform *Starting Copley Motion Explorer* (p. 3-3).

3. From the Main menu, select **Motor > Motor Data**. The **Motor Data Specification** screen displays.

4. The **Motor Data > Specification** screen (Figure 3-6) has four tab selectable screens: **Type, Feedback, Ratings, Electrical** and **Mechanical**. Enter motor data from the specification into those screens.

5. Select Save File As, to save the specification data as a .ccm motor file for future use.

7. Select **Calculate Amp Data**. ***Copley Motion Explorer*** models the data, performs calculations and displays new calculated data in the **Apply Motor Data** screen (Figure 3-7). After you complete **Auto Phasing** (discussed later in this chapter) you may make adjustments to data in this screen using the slide bars.

8. Select **Apply to Amp.** The **Amplifier Status Now!** screen displays.

9. Select **More.** The data modeled from the .ccm file is now associated with the appropriate amplifier and motor parameters on the **Amplifier Status Now!** screen.

10. Select **Save As Preset**, to save the data in the **Amplifier Status Now!** screen to flash memory on the amplifier.

11. **Selecting Save File As**, saves the data contained in the Amplifier Status Now! screen to the PC as a .cca file.

12. Review the next section, *Adjusting Calculated Motor Data*.

13. Go to the following section, *Encoder Checking*.

14. Go to the *Auto Phasing* section at the end of this chapter to verify electrical connections.

Adjusting Calculated Motor Data

When configuring new motors, you may want to adjust the *calculated* **Motor Data** (Figure 3-8) in the **Amplifier Status Now!** screen. This section takes this scenario into account.

Note: Calculated data is defined as motor data, which is displayed in the **Amplifier Status Now!** screen. It was previously *preliminary* motor data, which was entered into the **Motor Data >Specification** screen and calculated when the **Calc Amp Data** button was selected.

The **Current Limit Source** can be external or internal. When set to **External,** a voltage or resistance is used to set the peak current limit. When **Internal,** the continuous current limit and peak current limit values are used.

The average voltage can be limited to the motor by setting the **PWM Limit %**.

Phase Counts, or the number of encoder counts per electrical cycle (pole pair), is an important value which must be set accurately. The value may be determined using this equation:

Phase Count = Counts per rev. / no. of pole pairs

In this example (Figure 3-8), 4000 *counts per revolution divided by* 2 *pole pairs equals* 2000 *phase counts*.

Halls Present

Commutation Mode *can be set to either* ***Trapezoidal*** *or* ***Sinusoidal*** *If the motor has Hall sensors.* The ***Phase Mode*** *can be set to either* ***Hall-based*** *or* ***Algorithmic.***

You should proceed to the next sections *Encoder Checking* and *Auto Phasing.*

No Halls

If no Halls are present, then set ***Phasing Mode*** *to* ***Algorithmic*** *and* ***Phase Correct Mode*** *to* ***ON****. Also, set a* ***Phase Init Time*** *and set* ***Commutation Mode*** *to* ***Sinusoidal****.*

Proceed to the next sections *Encoder Checking, Auto Phasing* and *Algorithmic Phasing*.

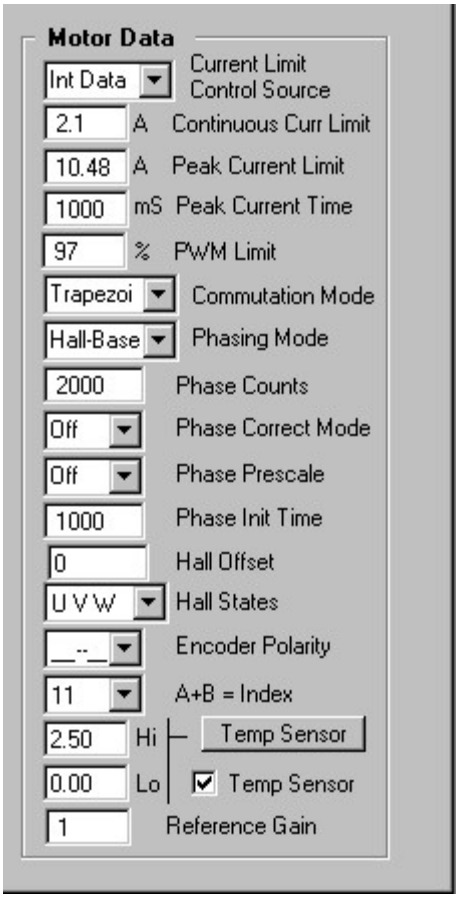


Figure 3-8-1 Adjusting Motor Data

Encoder Checking

The Encoder Checking routine verifies the integrity of the motor's encoder as follows:

- Checks for the presence of encoder quadrature pulses.
- Verifies the presence of an index pulse.
- Verifies that you have selected the correct A and B signal synchronization to the index pulse.
- Aids you in verifying the number of encoder lines.

Perform the **Encoder Checking** routine before attempting to auto phase a new motor. You may also use this routine if you suspect problems with your encoder.

Encoder Checking Routine

Warning: Before proceeding, make sure that the motor is *free to move bi-directionally* and ***not*** *connected to a load.*

---

1. Enable the Amplifier.

2. To access the Encoder Check screen (Figure 3-8), go to the **Main** menu and select **Tools > Encoder Check**.

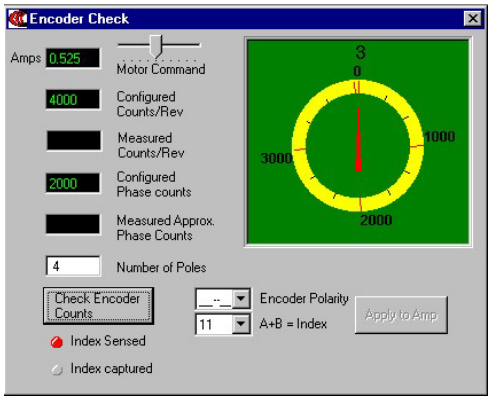


Figure 3-9 Encoder Check Screen

3. Checking the **Auto Update** feature enables the **Encoder Counts** gauge.

4. Verify the **Number of Poles** and make sure the value entered is correct for the motor you are using. The default value is 4.

5. On the **Amplifier Status Now!** screen (Figure 3-3), verify the data entered is complete. A *percentage* of the **Continuous Current Limit** will be used to drive the motor shaft.

6. Select the **Check Encoder Counts** button. The motor shaft should rotate one revolution.

   The **Encoder Check** screen should display **Configured Counts/Rev.** and **Measure Aprox. Counts/Rev.** As the shaft rotates the **Encoder Counts** gauge reflects rotation and encoder counts.

7. If the motor shaft did not rotate, use the **Motor Command** tuning slide to apply more current. Select **Check Encoder Counts** again. The amount of current applied is a percentage of the **Continuous Current Limit**. Tune and select **Check Encoder Counts** as necessary.

   (For a more precise method of measuring Approx. Counts, see *Manual Encoder Check* in next section.)

8. Successful completion of the Encoder Checking routine is signified by:

   a. The near match of data displayed in **Configure Counts/Rev.** and **Measure Approx. Counts/ Rev.** boxes.

   b. The **Index Sensed** indicator alternates between red and green as the index pulse is detected.

   c. The **Index captured** indicator turns green to signify that an index pulse was detected after one full revolution of the shaft. Also, there is proper synchronization of the index pulse to the A and B encoder pulses.

9. If the **Encoder Check** routine is unsuccessful, check physical connections, verify motor specifications, re-calculate the data and apply the data to amplifier. The routine may direct you to re-adjust **Encoder Polarity** and **A+B = Index** in the pull-down menus provided on the screen.

Linear Motor Encoder Check

You may perform a **Linear Motor Encoder Check**. This operation is performed using linear measurements. Note the differences between the screen using rotary measurements and the screen using linear measurements, which is shown below:

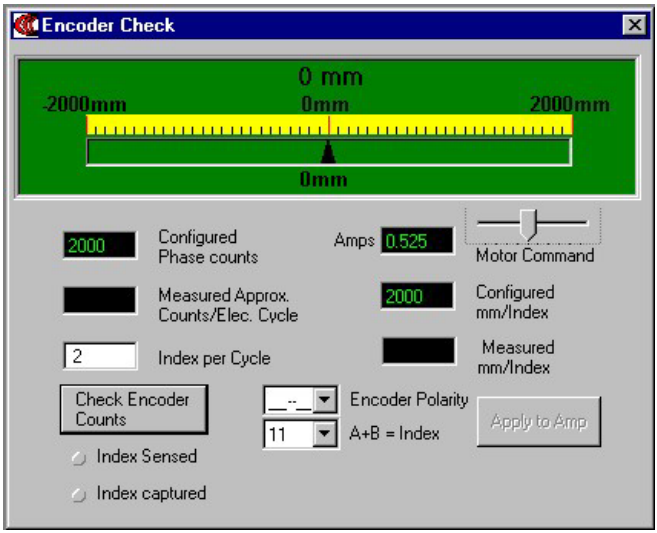


Figure 3-9-1

Auto Phasing

Refer to this section when wiring a new vendor motor to the amplifier. You can use the **Auto Phasing** feature for proper connection of three Hall signals, three motor phase wires and proper phasing of encoder wires. Execution of the auto phasing routine enables you to achieve proper phasing for trapezoidal and sinusoidal commutation.

Warning: Before proceeding, make sure that the motor is *free to move bi-directionally* and ***not*** *connected to a load.*

Note: Before you begin auto phasing, you must have completed the steps in the earlier sections, ***Installation Using a Vendor Specification and Motor*** and ***Encoder Checking***. On the **Amplifier Status Now!** screen:

- Motor Data should be complete (**Amplifier Status Now!** screen).
- **Current Loop** parameters, **"P"** and **"I"**, should have assigned values.
- **Operating Mode** should be set to **Torque**.
- **Command Amps** should be set to **0**. (After phasing you can reset this to a small current to check operation in **Torque** mode.)

When executing auto phasing, you define positive direction in the system.

Accessing and Using the Auto Phasing Screen

1. On the **Main** menu, select **Tools > Auto Phase**. The **Auto Phasing** screen (Figure 3-9) displays.
2. Check **Auto Update** to display the **Hall States**.
3. Select **Attempt Phasing** to initiate the routine.

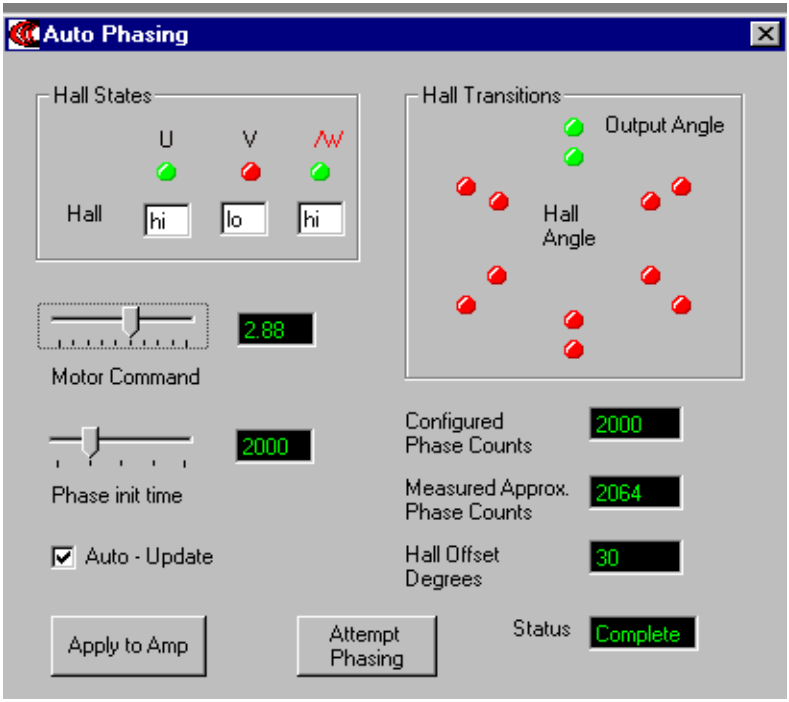


Figure 3-10 Auto Phasing Screen

Auto Phasing Routine

The auto phasing routine sequences through a number of subroutines. During this process, the auto phasing routine is dependent upon the validity of the specification data you entered into the **Motor Data > Specification,** and calculated, and applied to **Amplifier Status Now!** screen.

If you do not know the Hall state inversion or Hall offset, set them to no inversion and no Hall offset respectively. The routine will provide you with these parameters and prompt you to save them in the **Amplifier Status Now!** screen.

Warning: Whenever the routine prompts you to re-wire the motor, turn the power to the motor off.

The auto phasing routine has three main subroutines.

First, the routine checks for proper direction and commutation. You will notice the Hall Angle indicators turn on and off as the auto phasing routine cycles through the Hall state combinations.

CME prompts you to determine if the wiring at J2 and J1 is proper relative to motor's rotational direction (Figure 3-10). If necessary the routine prompts you to re-wire the motor (Figure 3-11).

With respect to direction, **CME** asks you to *"swap" a pair of wires. The swap combinations are motor wires UW, VW and UV.*

With respect to commutation, **CME** asks you to *"rotate"* motor wires. *Rotate left is the equivalent of shift U to W, W to V and V to U. Rotate right is the equivalent of shift W to U, U to V and V to W.*

Next the auto phasing routine checks Hall timing. You may again be prompted to reconfigure motor wires.

Finally, the auto phasing routine re-analyzes the timing data and determines if either:

- a Hall Offset value is required or,
- a change in the active level of the Hall states is detected.

If necessary, the routine generates a Hall Offset value and/or displays the required Hall states. Enter these value in the **Amplifier Status Now!** screen *and use them for all presets.* The offset value is typically a multiple of 30 — for example, 0, 30 or 60 degrees. *Any other Hall offset value means there may be a problem with the alignment of the Halls on the motor.*

Select **Apply to Amp** to save the values generated by auto phasing to flash memory on the amplifier.

After Auto Phasing

1. Open the **Amplifier Status Now!** screen. Set **Operating Mode** to **Torque**. Apply a small amount of current using the **Current** command and select **Apply Now** to test the **Torque** mode operation.

2. Check the **Motion Profile** (on the **Amplifier Status Now!** screen.

a. Input data to the **Position** parameter.

b. Input data to the **Velocity** parameter.

c. Input data to the Set **Accelertation** parameter.

d. Input data to the Set **Deceleration** parameter.

3. Select the **Apply Motor Data** screen, *which you should not have closed earlier*. Test the amplifier and motor using the **Position Loop** slide bars, with servo loop active.

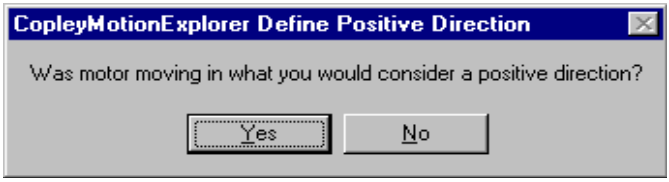

CopleyMotionExplorer Define Positive Direction
Was motor moving in what you would consider a positive direction?
Yes
No

Figure 3-11 Encoder Check

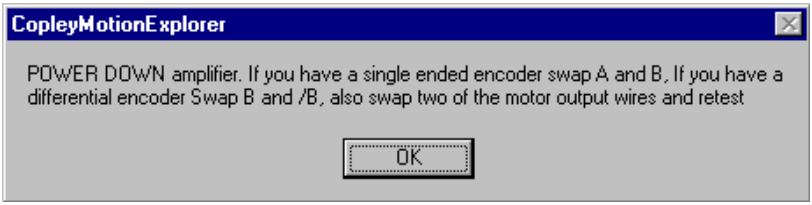

CopleyMotionExplorer
POWER DOWN amplifier. If you have a single ended encoder swap A and B, If you have a differential encoder Swap B and /B, also swap two of the motor output wires and retest
OK

Figure 3-12 Encoder Check

Algorithmic Phase Initialization

For motors that have quadrature encoders and no Hall sensors, algorithmic phase initialization can be used to initialize the phase for commutation.

Prerequisites

- Amplifier configured for motor, either by downloading an amplifier file *filename.cca* or applying calculated values using a motor data file *filename.ccm*.
- Motor connected to amplifier. When using a new vendor motor, the **Encoder Checking** and **Auto Phasing** routines should be executed to establish proper phasing.
- Values for current loop gain terms **P** and **I** are calculated or configured.

General Rules

- Algorithmic phasing should only be used if it is known that the motor is free to move in both directions, and that a brief uncontrolled move can be tolerated by the motor, mechanism, and load. (If this extra motion is not desired then use Hall sensors and Hall-based phase initialization.)
- Use caution if connecting a load.
- The **Phase Init Time** is used to set the duration of the phase initialization algorithm. The value used during auto phasing is sufficient. If set too fast, then improper phasing may result.

- The **Command Current** is used to move the motor. The value *derived* during auto phasing is sufficient. If set to low then improper phasing may result.
- The value for **Phase counts** must be correct.
- The **Phase correction** mode can be turned on. This will use the encoder index to correct thecommutation phase angle. This will correct for noise on the encoder line or a non integer number of phase counts.
- Use **PWM% limit**, **current limits**, and slow blow fuses o protect high cost motors.
- **Encoder Polarity**, normally low pulse high index **"_-_"**, or normaly high pulse low index **"-_-"**, must be set correctly for proper algorithmic phasings, or phase correction. Also, the location of the index pulse **A+B = Index**, must be set correctly for proper detection of the index pulse.

  Example: If the index pulse is high during the time that encoder line A and B are high then select "**11**" for proper **A+B Index**.

Method A: **Software Phase Initialization**

1. Start with no load.

2. Set **Commutation** mode to Sinusoidal.

3. Set **Phase** mode to algorithmic.

4. Set Phase Correct mode to On.

5. Set **Phase Init Time** to 4000 ms.

6. Set **Command %** to sufficient value.

7. On **Amplifier Status Now!** screen, select **Amp OK >> Phase initialized >> Attempt Phase initialzation**.

8. The motor should “**wiggle**” with in 1 electrical cycle for 4 seconds. Phase initialization should now be OK.
9. Repeat this function several times to verify the operation.
10. Save the values to a preset.

Method B: **Phase Initialization on Power-up**

1. Start with no load.
2. Set **Commutation** mode to Sinusoidal.
3. Set **Phase** mode to algorithmic.
4. Set **Phase init. time** to 400 ms.
5. Set **Phase correct** mode to On.
6. Set **Command Current** to a sufficient value, usually provided during Auto Phasing routine. (This value will be set to 0 after algorithmic phasing.)
7. Save to a **Preset** that will be used on power-up.
8. Power down completely.
9. Power up. The motor should "wiggle" within 1 electrical cycle for 4 seconds. Phase initialization should be complete.
10. Save the values to a **Preset**.

Tuning After Auto Phasing

With a new motor applied to a load, you may want to tune the system. Select the **Apply Motor Data** screen and use the scale bars described below to adjust the system response.

Slide	Function
Current Loop:	
Bandwidth	Used to increase or decrease the current loop response. If proper values for motor inductance and resistance are entered, the default current loop response is typically > 1kHz.
Peaking	Used to affect the amount of overshoot of the current loop response. Typical peaking is about 5%. The default current loop valuse calculated by the model aare highly reliable, so it is not necessaary to change them.
Position Loop:	
Bandwidth	Used to change the system bandwith as it affects PID values, ""I" and "D" mainly.
Gain	Used to change the overall system gain by affecting the Kout term.
Stiffness	Used to change system stiffness by affecting the "P" term.
Integrator	
Kaff	Used to change the acceleration feed forward by affecting the Kaff term. Used to reduce position error during acceleration.
Kvff	Used to change the velocity feed forward fy affecting the Kvff term. Used to reduce position error during velocity.

Table 3-1 Tuning After Auto Phasing

Chapter 4 Operating Modes

This chapter describes operating modes that you may select to run with your amplifier and motor. You select these modes using the ***Copley Motion Explorer***™ software.

Operating modes include:

- **Torque** mode
- **Position** mode
- **Velocity** mode
- **Digital Position** mode

For detailed descriptions of the ***Copley Motion Explorer***™ screens, see Chapter 5.

Torque Mode

By selecting **Torque** mode, you can configure the amplifier for a torque (current) loop.

Note: In torque mode, the following apply:

- current loop gains and limits
- command current and current loop values

The values for motion profile and position loop are *not* applicable.

Selecting Torque Mode

1. From the **CME Main** menu, select the **Amplifier** pull down menu.
2. Select **Status Now!** to display the **Amplifier Status Now!** screen.
3. Scroll right until the **More** button is displayed. Select the button to display the *full* **Amplifier Status Now!** screen.
4. Select Torque from the **Operating Modes** drop down menu

Note: For proper operation, always stop the motor before you select a different operating mode.

Torque Mode with Encoder and Hall

Use this procedure for torque mode operation. Applications include microprocessor control systems that get position feedback from the motor encoder and require current from the amplifier in response to a control voltage at the inputs.

Prerequisites

- The amplifier must be configured for the motor by downloading an amplifier file *filename.cca* or by applying calculated values using a motor data file *filename.ccm*.
- The motor must be connected to the amplifier. When using a new vendor motor, the Encoder checking and Auto phasing routines should be executed in order to establish proper phasing.

Procedure

1. Disconnect the load from motor when testing **Torquemode** operation.
2. Set the **Operating mode** to torque and **Command** to 0.
3. Verify **Current Loop Gai**n P>0 and I>0, C**urrent Limits**, **Phasing Mode** Hall-Based.
4. Set commutation mode to **Trapezoidal**.
5. Apply changes then enable the amplifier.
6. Increase the command torque by 250mA and click **Apply**. Repeat until motion occurs. Reverse direction using a negative current.
7. Change commutation mode to **Sinusoida**l. Apply command torque and verify the same direction of motion.
8. Check **Current Loop Bandwidth**. (Optional for properly calculated values.)
9. Save settings to desired preset and an amplifier file –- *filename*.cca.

Application Example: Simple drive torque mode.

Preset 0: Command -1 Amp, PWM Limit 10% {Drive to neg. limit with 1.25Amps (torque) and 16Vavg. (speed) limit.}
Preset 1: Command +1 Amp, PWM Limit 10% {Drive to pos. limit with 1.25Amps (torque) and 16Vavg. (speed) limit.}
Preset 2: Command +4 Amps, PWM Limit 97% {Drive to pos. limit with 5Amps (torque) and no voltage limit.}

Figure 4-1 illustrates typical connections in **Torque** mode.

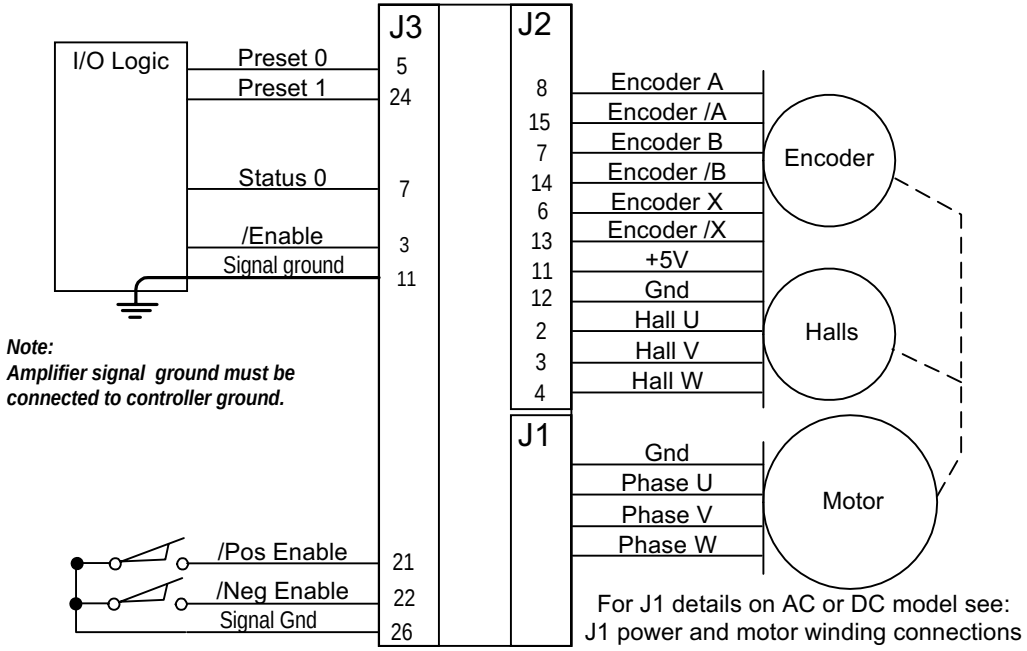


Figure 4-1 Typical Connections in Torque Mode

Torque Mode Using a ±10V Reference

In **Torque Mode**, you can also set up the system to command torque from a ±10V reference.

In **Torque Mode**, using a ±10V reference the following apply:

- current loop gains and limits
- current loop values

The values for **Command Current**, **Motion Profile** and **Position Loop** are *not* applicable.

Selecting Torque Mode Using a ±10V Reference

1. Select the **Amplifier** pull down menu from the **CME Main** menu.
2. Click **Status Now!** to display the **Amplifier Status Now!** screen.
3. Scroll right until the **More** button is displayed. Click the button to display the *full* **Amplifier Status Now!** screen.
4. Select **+/- 10V>Torque** from the **Operating Modes** pull down menu.

Position Mode

By selecting **Position** mode, you can configure the amplifier for a position loop driving a current loop.

Note: The current loop gains and limits apply to the torque loop that operates inside the position loop. Within the position loop, the selected values for the motion profile and position loop are applicable.

Selecting Position Mode

1. From the **CME Main** menu, select the **Amplifier** pull down menu.
2. Select **Status Now!** to display the **Amplifier Status Now!** screen.
3. Scroll right until the **More** button is displayed. Select the button to display the *full* **Amplifier Status Now!** screen.
4. From the **Operating Modes** pull down menu, select **Pos>Torque**.

Position Mode with Encoder and Halls

Use this procedure for position mode operation. Applications include programmable logic controllers (PLC's) that require profiled moves from the amplifier in response to logic levels at the inputs.

Prerequisites

- The amplifier must be configured for the motor, either by downloading an amplifier file *filename.cca* or applying calculated values using a motor data file *filenam.ccm*.
- Motor connected to amplifier. When using a new vender motor, the Encoder checking and Auto phasing routines should be executed to establish proper phasing.
- Torque mode operation should be verified and functioning properly.

Procedure

1. Disconnect load from motor when testing position mode operation.
2. Set the **Operating mode** to **Position>Torque** mode, enter **Motion Profile**.
3. Verify **Position Loop** tuning parameters.
4. Set **Actual Position** to 0 by pressing **set** (top left hand corner of Status Now screen). Then set **Target Position** to 0, by entering 0 for the position value (located in the more screen in the motion profile section.)
5. Apply changes, then enable the amplifier. The motor should be in a stationary position loop.
6. Enter a new **Target Position** then click **Apply**. A motion profile should execute.
7. Save the settings to **Preset 0** (Any will do).
8. Enter **Target Position** 0 and click apply. The profile should return to the 0 position. Save settings to preset 1.
9. Toggle between presets 0 and 1. The Trace can be used to monitor the profile.
10. Check **Position Loop Bandwidth**.
11. Verify that there is no current or voltage limiting during motion profiles
12. Save to an amplifier file — *filename*.cca

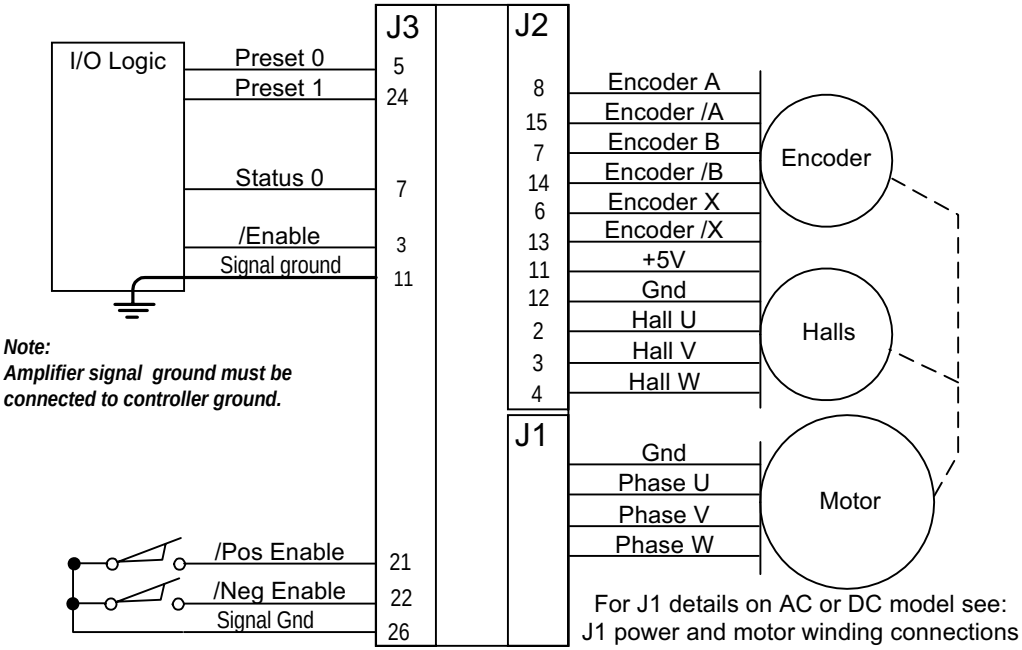
Application: Simple pick and place.

Preset 0: Velocity 0, Position loop values set for soft tuning. Stay in position with no count jitter.

Preset 1: Position 0, Position loop values set for aggressive tuning. Move to pick position.

Preset 2: Position X, Position loop values set for aggressive tuning Move to place position.

Figure 4-2 illustrates typical **Position** mode connections.



Note:
Amplifier signal ground must be connected to controller ground.

Figure 4-2 Typical Connections (Position Mode)

Velocity Mode

In **Velocity** mode, you can configure the amplifier for a velocity loop, in a position loop driving a current loop. The velocity loop operates as a position loop that never reaches the destination position.

Note: The torque loop gains and limits apply to the torque loop that operates inside the position loop. In **Velocity** mode, *some* of the values for motion profile and **all** of the values for position loop values are applicable.

In **Velocity** mode, you can also set up the system to command velocity from a ±10V reference. This is described later in this section.

Selecting Velocity Mode

1. From the **CME Main** menu, select the **Amplifier** pull down menu.
2. Select **Status Now!** to display the **Amplifier Status Now!** screen.
3. Scroll right until the **More** button is displayed. Select the button to display the *full* **Amplifier Status Now!** screen.
4. From the **Operating Modes** pull down menu, select **Pos>Torque.**
5. From the **Motion Profile** pull down menu, select **Velocity**.

Note: For proper operation, always stop the motor before you select a different operating mode.

Velocity Mode Using a ±10V Reference

In **Velocity** mode, you can also set up the system to command velocity from a ±10V reference.

Selecting Velocity Mode Using a ±10V Reference

1. From the **CME Main** menu, select the **Amplifier** pull down menu.
2. Select **Status Now!** to display the **Amplifier Status Now!** screen.
3. Scroll right until the **More** button is displayed. Select the button to display the *full* **Amplifier Status Now!** screen.
4. From the **Operating Modes** pull down menu, select **+/-10V>Pos>Torque.**
5. From the **Motion Profile** pull down menu, select **Velocity**.

Note: For proper operation, always stop the motor before you select a before you select a different operating mode.

Digital Position Mode

In **Digital Position** mode, you configure the amplifier for a digital position loop driving a current loop.

Note: The current loop gains and limits apply to the current loop operating inside the digital position loop. In this mode, *some* of the values for motion profile and *all* of the values for current loop are applicable.

Selecting Digital Position Mode

1. From the **CME Main** menu, select the **Amplifier** pull down menu.

2. Select **Status Now!** to display the **Amplifier Status Now!** screen.

3. Scroll right until the **More** button id displayed. Select the button to display the *full* **Amplifier Status Now!** screen.

4. From the **Operating Modes** pull down menu, select **Pos->Torque.**

5. From the **Motion Profile** pull down, select **Gear**.

6. From the Digital Position Input Source pull down menu, select one of the following:

- **A/B Encoder,** where quadrature encoder pulses are used as a master encoder to position the motor.
- **CW / CCW**, where pulses on the clockwise line produce CW rotation and pulses on the counter clockwise line produce CCW rotation.
- **Pls / Dir**, where stepper pulse and direction are used to position the motor.

7. Under **Digital Position Input**, set the **Gear Ratio** value to scale the number of digital input counts to the number of encoder counts.

Digital Mode Using a Master Encoder

Use this procedure for master encoder mode operation.

Prerequisites

- Amplifier configured for motor, either by downloading an amplifier file *filename.cca* or applying calculated values using a motor data file *filename.ccm*.
- Motor connected to amplifier. When using a new vendor motor, the Encoder checking and Auto phasing routines should be executed to establish proper phasing.
- Torque mode operation verified and functioning properly.
- Position mode operation verified and functioning properly.

Procedure

1. Disconnect load from motor when testing master encoder mode operation.

2. Set the operating mode to **Pos>Torque** mode and enter **Motion Profile** values.

3. Set profile to **Gear** and **Digital Position** input to A/B encoder.

4. Set the **Gear Ratio** value.

5. Set **Kaff** and **Kvff** to 0. (These terms can produce noise at the motor.)

6. Apply changes then enable the amplifier. The motor should be in a stationary position loop.

7. Rotate the master encoder and verify that the slave encoder follows. (Motion profile limits apply.) The Trace can be used to monitor the profile.

source.Encoder source.

8. Check Position Loop Bandwidth

9. Verify that there is no current or voltage limiting during motion with a load.

10. Save to an amplifier file filename.cca

Application: Simple Gearing with Phase Advance and Retard

Preset 0: Gear ratio 1:1 (Slave:Master ratio 1 : 1, tracking.)

Preset 1: Gear ratio 1.2:1 (Slave:Master ratio 1.2 : 1, advancing.)

Preset 2: Gear ratio 1:1.2 (Slave:Master ratio 1 : 1.2. retarding.)

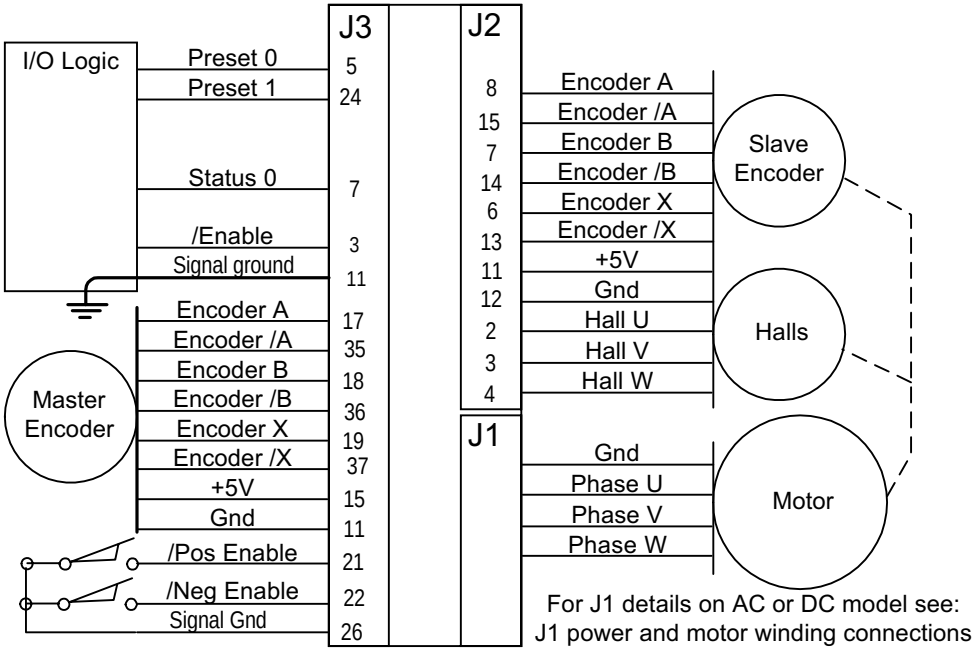


Figure 4-3 Digital Position Mode Using a Master Encoder

Notes:

Chapter 5 Using Copley Motion Explorer

This chapter describes the ***Copley Motion Explorer™*** **(CME)** user interface.

The ***Copley Motion Explorer*** program is powerful software that enables you to optimize servo parameters for your application. High level tasks that you perform with **CME** are described in Chapter 1.

CME features and functions are available to you via a series of easy-to-use Windows-based screens. To open the initial **CME Welcome** screen.

1. In Windows, Select **Start> Programs> Copley Motion Explorer> Copley Motion Explorer**.

2. The **CME Welcome** screen (Figure 5-1) should open. Selecting either **On-Line** or **Off-Line** provides access the **CME Main** window (Figure 5-2).

Note: This chapter is organized as if you were accessing screens sequentially, from left to right, on the **Main** menu.

Copley Controls Corp.
Welcome to
Copley Motion Explorer
Version 1.2.16
Click the buttons below to select the way you want to work:
On-Line
On-Line: connected to an amplifier for programming and setup
Off-Line
Off-Line: for programming amplifiers, motors, or complete axes for downloading later
DII Build Date : Apr 20 2000 15:54:15
Copyright (c) 1999, 2000 - Copley Controls Corporation
Exit

Figure 5-1 Welcome Screen

Main Window

The Main window consists of the Main window controls, the **Main** menu, the **Amplifier Explorer** window, the screen display area and the **Status Line**.

The Main window controls are located in the top row of the window, and consist of the **CME** icon and the minimize, maximize and close window buttons.

Selecting the **CME** icon pull-down menu provides access to the standard window controls: **Restore, Move, Minimize, Maximize** and **Close**.

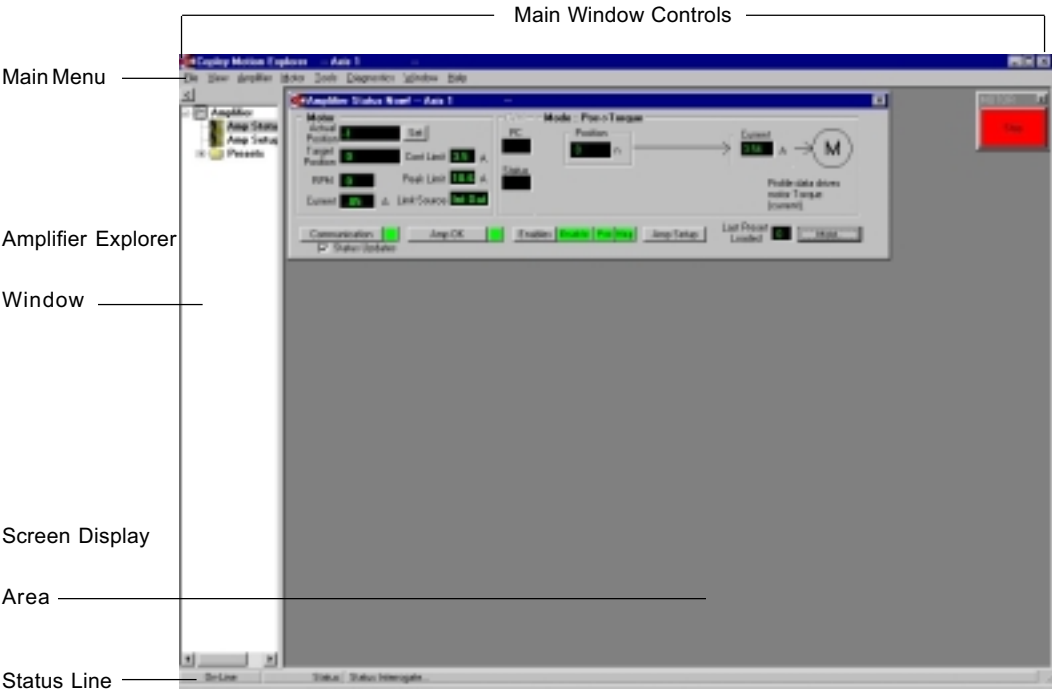


Figure 5-2 Main Window

Main Menu

The **Main** menu has a number of pull-down menus. They are: **File, View, Amplifier, Motor, Tools, Diagnostics** and **Help.**

Figure 5- 3 Main Menu

File Menu

The File pull-down menu provides you with file management options.

Option	Function
New	Create a new motor file .ccm using the motor form or an amplifier file .cca using the preset manager and the Amp Setup screens.
Open	Opens a motor .ccm, amplifier .cca, or axis .cxa file from the Copley Motion Explorer folder. The .cxa file contains all the amplifier and motor data ,together with the axis name, to form a single axis file for replicating an axis.
Save	Save *presets* as a .cca file, motor data as a .ccm file., or complete axis data as a .cxa file. You must use the **Save As Preset** button on the **Amplifer Status Now!** screen before you can Save data as a file.
Save As	Save .cca, .ccm, or .cxa files as another name.

Table 5-1 File Menu

View Menu

The **View** menu has one option: **Explorer**. When it is selected, the **Preset Select** window is displayed. You can use the **Preset Select** window to access the **Amp Status Now!** and **Preset Manager** screens.

Amplifier Menu

The **Amplifier** menu has the following options: **Connect to Host** (for On-Line Connection)**, Amp Setup, Status Now!** and **Preset Manager**. Selecting an option opens the related screen(s).

On-Line Connection Screen

The **On-Line Connection** screen has the following option buttons: **Comm X, Desired Baud, Connect, Upload, Continue** and **Work Offline**.

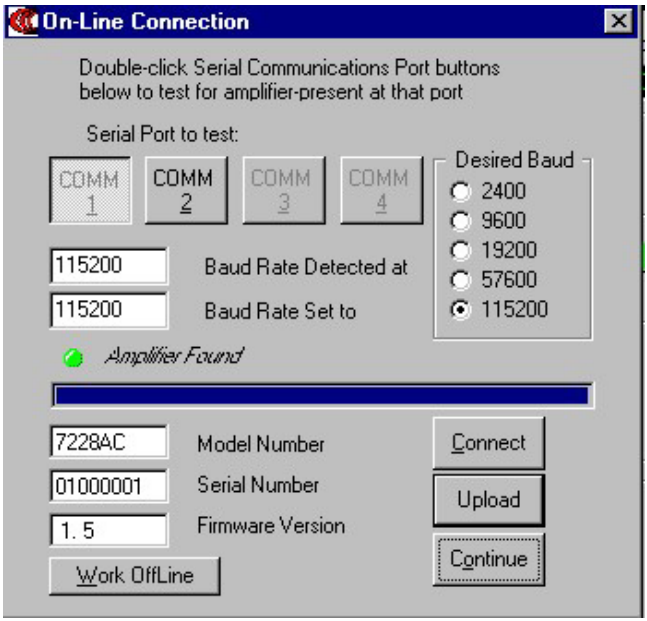


Figure 5-4 On-Line Connection Screen

Normally, you use the **On-Line Connection** screen during installation of, or re-connection to, an amplifier.

Option	Function
Comm X	Select a communications port on your PC (Comm1 to Comm4) from which your PC is physically connected to the amplifier.
Desired Baud	Select a baud rate (2400 thru 115200) for communications between the PC and amplifier.
Connect	Select connect to initialize full communications between the PC (and **CME**) and the amplifier.
Upload	Interrogate amplifier and upload presets from the amplifier to the PC or laptop.
Continue	After successful connection, select Continue to open the Amplifier Status Now! screen. (Successful connection indicated when Amplifier Found indicator turns solid green and the correct Model, Serial Number and Firmware Version display on the screen.)
Work Offline	Provides no connection to the amplifier, but allows for the following: tasks to be performed: entering and saving motor data files, and using the preset manager to manipulate amplifier data files.

Table 5-2 On-Line Connection Screen

Amp Setup Screen

The **Amp Setup** screen (Figure 5-5) has the following options: **Serial Port, Amp Data, Active Level Selection, Preset Inputs, Preset Input Resistors, Reset Edge, Apply to Amplifier, Store to Amplifier Flash** and **Clear Changes.**

Note: These parameters are global amplifier settings and apply to all presets.

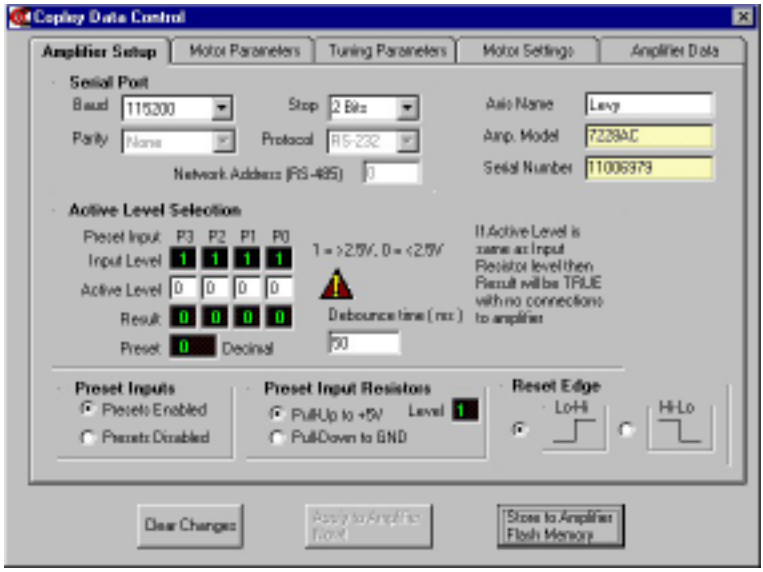


Figure 5-5 Amplifier Setup Screen

Option	Function
Serial Port	Set the Baud, Parity, Stop bits and Protocol. If using RS-485, set the Network Address.
Amp Data	Displays unit serial and model numbers. Remarks = user-defined mnemonic.
Active Level Selection	Select active levels as you might configure hardware on a controller. Also, displays present input level detected, hex (Result) and decimal (Preset) results.
Debounce Time (ms)	Sets the time required for the Preset switches to have complete closure. i.e., switch noise complete.
Preset Inputs	When disabled, ignore Preset iput lines (J3-5, J3-24, J3-6, J3-25on pendant).
Preset Input Resistors	Sets Preset Input Level to 1 or 0. 1 = Pull-up to +5V, 0 = Pull-down to Gnd.
Reset Edge	Select **Reset** line signal active on either rising of falling edge.
Apply to Amplifier	Store parameters in RAM on amplifier (for temporary use).
Store to Amplifier Flash	Apply amplifier global setup to flash memory on amplifier (for permanent use).
Clear Changes	Clear changes to parameters displayed on screen.

Table 5-3 Amplifier Setup Screen Options

Amplifier Status Now! Screen

The **Amplifier Status Now!** screen displays amplifier status and parameters, which contain adjustable data. Initially, only the top third of the screen displays to indicate Motor status including: **Actual Position, Target Position, RPM, Torque, Cont. Limit, Peak Limit, Limit Source and Mode** (Table 5-4).

Select **More** to display the entire screen.

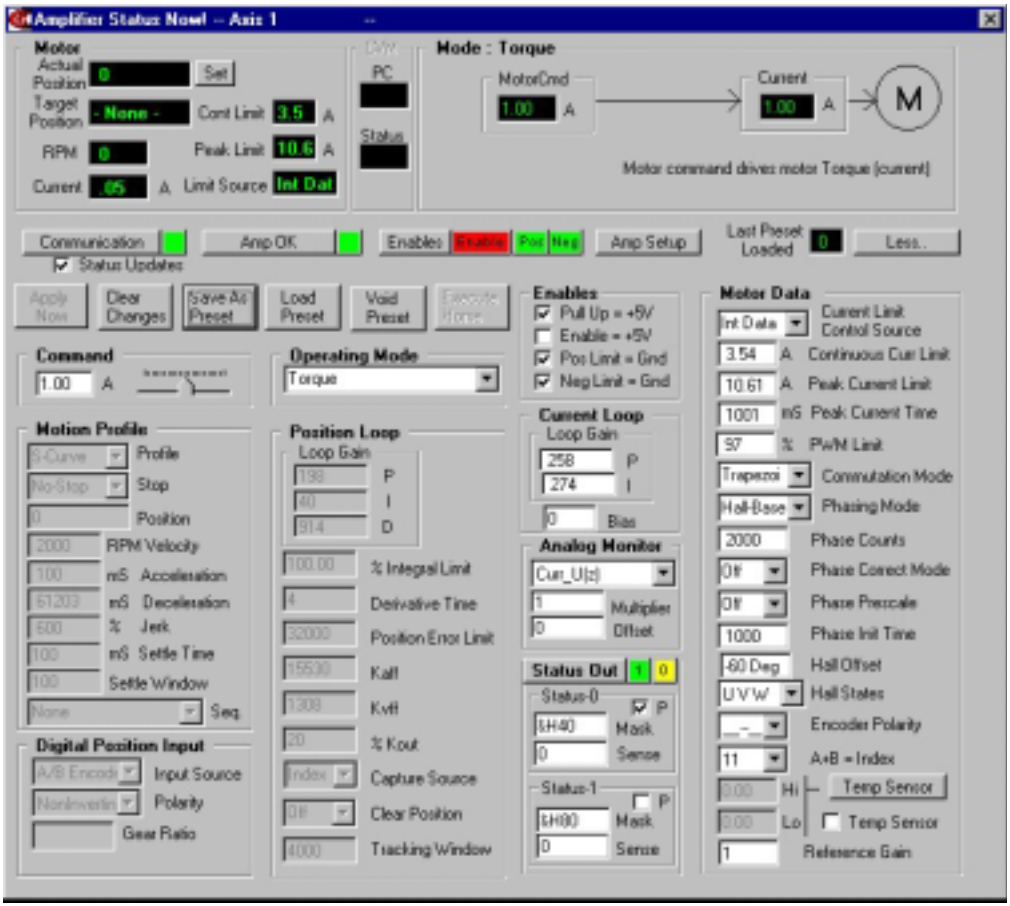


Figure 5-6 Amplifier Status Now! Screen

Motor Status:	Note(s)
Actual Position	Displays actual position count Max. = (+ /- 2^{31}-1).
Target Position	Displays final position count, target of preset profile. Max. = (+ /- 2^{31}-1).
RPM	Actual velocity measured by amplifier and displayed in rotations per minute. RPM Max. = ((4MHz Counts/Seconds) \(Encoder Counts/Revolutions)) x 60. RPM Max. should not exceed motor specification.
Torque	Actual torque measured by amplifier .
Cont Limit	Present value if continuous current limit. Set in Motor > Data > Specification screen. Calculated from contionuous torque, 10 Amps Max.
Peak Limit	Present value of peak current limit. Set by external or internal values. 20 Amps Max.
Limit Source	Peak current limit source can be internal value or external voltage. Range = 0 - 20 Amps.
Mode: (Type)	Displays selected Operating Mode in a functional block diagram. The type of status that follows, i.e., position and current, will vary depending upon mode of operation.
Set button	Allows you to enter a pre-determined actual position.

Table 5-4 Motor Status and Mode

Beneath the current motor status and mode displays are a series of buttons and indicators, which pertain to status, errors, etc. (Figure 5-7).

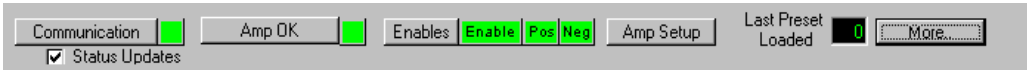


Figure 5-7 Status Buttons and Error Indicators (Amp Status Now ! Screen)

Communications Button

Selecting the **Communication** button (Figure 5-6) displays the **ON-Line Connection** screen. When the Communication indicator is green, there is a good connection. When **Status Updates** is on, the indicator refreshes at the same rate as the updates.

Amp Ok Button

The **Amp OK** button is a useful troubleshooting tool. If an **AMP OK** indicator is not green during operation of the amplifier, select it to display a series of indicators (Table 5-5). Each indicator also serves as a button, which you may select for options and information.

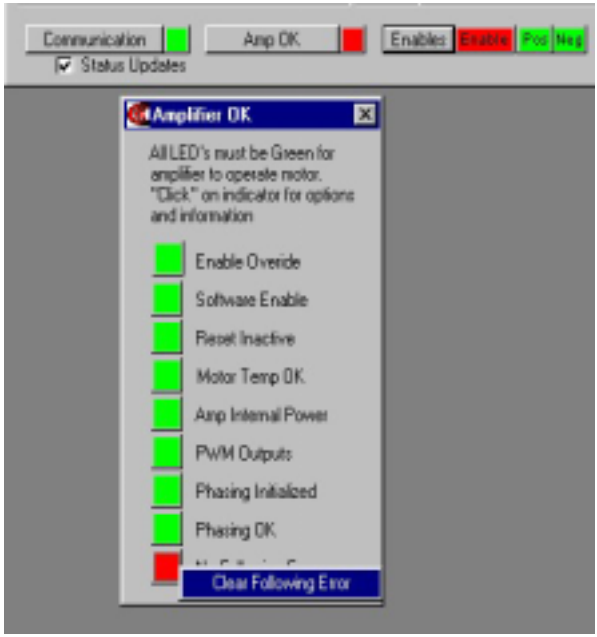


Figure 5-8 Amplifier OK Screen

Indicator\Button	When not green...
Enable Override	Use to the clear/set red software Stop button.
Software Enable	Use the software to enable and disable the amplifier.
Reset Inactive	Check the Reset switch on the pendant board.
Motor Temp OK	Check the motor Temp Sensor screen.
Amp Internal Power	A loss of internal regulator power has occurred. Check connections at J1 on the amplifier.
PWM Outputs	Indicates problem with power board. Attempt to clear with this button or reset and possibly wait for assembly to cool down.
Phasing Initialized	Indicates that sinusoidal commutation has not been initialized. Use alogrithmic phasing if Halls not present. If Halls present, then use Hall-based phasing.
Phasing OK	Phasing has been lost. (When green, Indicates that a move can be made).
No Following Error	Indicates that the position error is greater than tthe set limit.

Table 5-5 Amplifier OK Indicators

Enables Button

Select the **Enables** button to display the **Enable Inputs** screen. This screen allows you to view the Enable, Positive Enable and Negative Enable input lines (to switches on the pendant board). Switching the **Pos** or **Neg** enable to off halts the motor's rotation.

When properly connected to a motor, the **Enable, Pos** and **Neg** indicators should be green. If not, use the **Amplifier Status Now!** > **More** screen to change the active levels of the **Enable Inputs**. Or, if the **Enable** indicator is red, set the **ENAB** switch on the pendant down (ON).

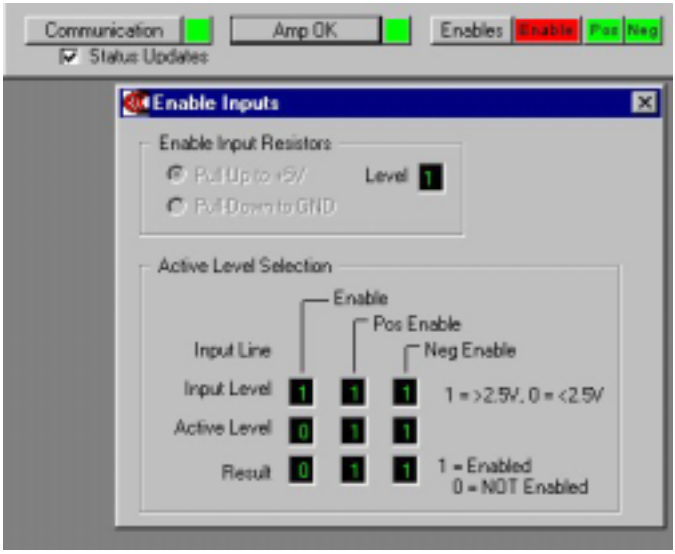


Figure 5-9 Enable Inputs Screen

Amp Setup Button

This button (Figure 5-10) displays the **Amp Setup** screen described earlier in this section.

Last Preset Loaded

This indicator (Figure 5-6) displays the number of the last preset loaded — displayed.

More/Less Button

Clicking this button (Figure 5-6) changes the **Amplifier Status Now!** screen by increasing or decreasing the displayed portion of the window.

Status Update Checkbox

Check this box (Figure 5-6) to update the status information in the **Amplifier Status Now!** screen. Updates occur at pre-determined intervals defined in the **Tools > Options > Communications** screen.

Parameter Control Buttons

On the **Amplifier Status Now!** screen (Figure 5-10) there are five parameter control buttons (Table 5-6).

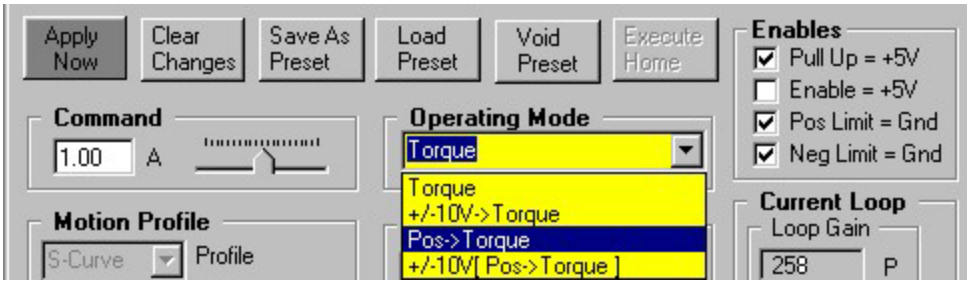


Figure 5-10 Amplifier Status Now! Screen Segment

Button	Function
Apply Now	When amplifier connected, loads the current parameters in the **Amplifier Status Now!** screen to active registers, or active RAM, on the amplifier.
Clear Changes	Deletes changes (highlighted in yellow) displayed in **Amplifier Status Now!** screen.
Save as Preset	Saves parameters currently displayed in **Amplifier Status Now!** screen to flash memory for selected preset on amplifier.
Load Preset	Uploads a specified preset from amplifier flash memory of selected preset and displays it (locally) in **Amplifier Status Now!** screen.
Void Preset	Deletes specified preset prameters in flash memory on the amplifier.

Table 5-6 Parameter Control Buttons

Command Current

The **Command Current** option (Figure 5-10) is normally used in **Torque mode**. You manually insert, or use the slide bar to increase, the current that is applied to the motor. The maximum output current of the amplifier is limited to 20 amps.

You can also use the **Command Current** in **Position** mode (**Pos>Torque**) with algorithmic phasing. In this mode, the command value is used by the motor as a reference point, when you perform algorithmic phasing.

Enables

The **Amplifier Status Now!** screen contains check box controls several **Enable** lines (Figure 5-10). Select the enables as you would set digital logic on a controller. For example, if the polarity is reversed, set the enable lines low.

Operating Mode

The **Amplifier Status Now!** screen contains the **Operating Mode** pull-down menu (Figure 5-10). For more information, see **Chapter 4 Operating Modes.**

The pull down menu provides the following modes:

Torque..... Torque mode (use Command Current)

+/-10V-> Torque..... Position mode

Pos>Torque..... Velocity mode

+/-10V [Pos->Torque]..... Digital Position mode

Note: For proper operation, always stop the motor before you select a different operating mode.

Motion Profile

Initial Motion Profile parameters (Figure 5-11) are calculated from:

- data you input on the **Motor > Motor Data > Specification** screens

or

- parameters that you upload from a .cma file to the **Motor > Motor Data > Specification** screens.

You can manually change/adjust these parameters (Table 5-7) to satisfy your application requirements. You can save all of the parameters on the **Amplifier Status Now!** screen as one of 16 possible presets. You may also save the parameters on the **Amplifier Status Now!** screen as a *.cca file.

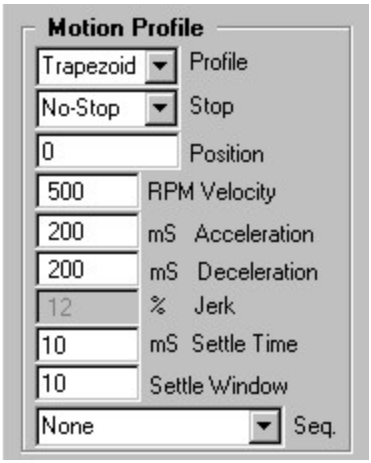


Figure 5-11 Motion Profile Parameters

On execution of a preset, the data assigned to a motion profile parameter is used to perfrom the motion profile.

Parameter	Note(s)
Profile:	
Trapezoid	A Trapezoid profile has a specified maximum acceleration, deceleration and velocity. They are used to calculate trajectory to a position.
Velocity	A Velocity profile is is a position loop that never gets to the destination.
S-Curve	If you select a sinusoidal S-curve, then you must set a **Jerk** value. S-Curve is used to reduce positive error during acceleration and deceleration. Also, reduces mechanical distortion to the system.
Gear	The ratio of Digital input counts to motor encoder counts. Value = (slave counts\master counts) .
Stop:	
No-Stop	Used to turn off a previously set stop comand.
Abrupt-Stop	Instantly, without deceleration, stops the motor (without any deceleration phase).
Smooth-Stop	Uses programmed deceleration value and profile shape for the current mode to stop the axis. Not used with **Gear** profile mode.
Position	Sets the trajectory destination of the motor. Used with **Trapezoid** and **S-curve** profile modes. Max. = (+/- 2^{31}-1). Values < 0 only in Velocity mode.
Velocity (RPM)	Sets the maximum velocity for the motor Do not change with a motor in motion in **S-curve** profile mode. RPM Max. = ((4MHz Counts/Seconds)\(Encoder Counts/Revolutions)) x 60.
Acceleration	Sets the maximum acceleration. Not used with **Gear** profile mode.
Deceleration	Sets the maximum deceleration. Not used with **Gear** profile mode. If = 0, then Acceleration value is used.
Jerk	Sets the Jerk value (rate of change of acceleration) for **S-curve** profile only. The 1% value approaches a T**rapezoid** profile.
Settle Time	Sets the time, in number of cycles, to reach the steady state position within the settle window. 1 servo cycle equals 205 microseconds. Range = 0 to 2^{15}-1 servo cycles.
Settle Window	Sets the position range within which the motor must remain for the duration specified by SettleTime. Range = 0 to 2^{15} -1 counts.

Table 5-7 Motion Profile Parameters

Position Loop

An amplifier may use a **Position Loop** to hold a position. You can use the **Motor > Data > Specification** screen to *calculate* initial position loop values. Using the tuning slides on the **Apply Motor Data** screen, adjust the values until they are within a usable range.

Table 5-8 describes **Position Loop** parameters.

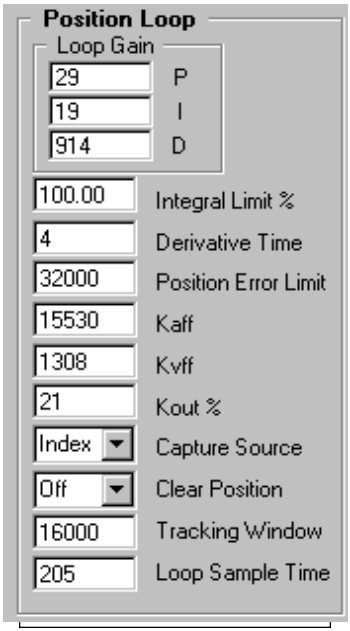


Figure 5-12 Position Loop Parameters

Parameter	Note(s)
Loop Gain:	
P	A force proportional to error (between actual and commanded positions).
I	A force proportional to error integrated or accumulated over time.
D	A force proportional to the derivative or rate of change of error.
Integral Limit	Sets the integration-limit of the digital servo filter for the motor. Must be >0.
Derivative Time	Sets the sampling time, in number of servo cycles, for the servo filter to use in calculating the derivative term for the specified axis. Must be >0.
Position Error Limit	Sets the absolute value of the maximum position error allowed by the digital servo filter for the motor. If the position error exceeds this limit, a motion error occurs. Max. = (+/- 2^{16}-1).
Kaff	Sets the acceleration feed forward gain of the digital servo filter for the motor.
Kvff	Sets the velocity feed forward gain of the digital servo filter for the motor.
Kout	Output gain at end of tPID transfer function. Must be >0.
Capture Source:	Determines which encoder signal is used to trigger the high-speed capture of the actual position of the motor
Index	Encoder index pulse. (Default capture source.)
Home	Reserved for future use.
Clear Position Error	When set to on, clears position error in postion buffer if motor shaft is out of position at initialization. Thus, the current destination position equals the actual postition.
Tracking Window	Sets boundaries for actual motor position. If the boundaries are crossed during trajectory then the tracking indicator is set.
Loop Sample Time	Amplifier's digital control loop sampling time. This parameter is factory set to 205 microseconds.

Table 5-8 Position Loop Parameters

Current Loop

You can use the **Motor > Data > Specification** screen to calculate initial current loop values. Typical values produce 1kHz current loop bandwidth, depending on power supply voltage, motor resistance, inductance and **P** and **I** values.

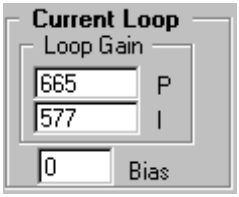


Figure 5-13 Current Loop Parameters

Parameter	Notes
Loop Gain:	
P	A force proportional to error (between actual and commanded current).
I	A force proportional to error integrated or accumulated over time.
Bias	Sets the bias voltage of the digital servo filter.

Table 5-9 Loop Gain Parameters

Motor Data

You can set the Motor Data parameters (Table 5-10) in several ways:

- Obtain a .cca file from Copley Controls. Opening the file displays the **Motor Data** in the **Amplifier Status Now!** screen.

- Upload a .ccm file, provided by Copley controls, to the **Motor Data > Specification** screen.

- Open the **Motor Data > Specification** screens and manually input the data from your motor's specification.

In the last two scenarios, select **Calculate Motor Data** (on the **Motor Data > Data Specification** screen). The modeled data should be displayed in the Apply Motor Data screen. Selecting the **Apply to Amp** button displays the **Motor Data** on the **Amplifier Status Now!** screen.

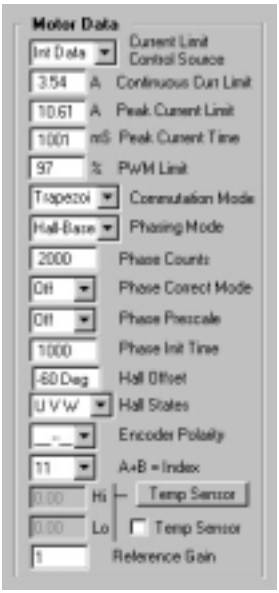


Figure 5-14 Motor Data (Amplifier Status Now! Screen)

Parameter	Note(s)
Current Limit Control Source:	Selects either an internal or external current limit control source for the motor.
Int Data	Internal peak and continuous current limit values use. Must be > continuous current.
Ext Input	External voltage used to set peak current. Range = 0 - 10V.
Continuous Current Limit	Sets the continuous current limit for the motor. Used to protect the motor in a stalled condition. Range = 0 - 10 Amps.
Peak Current Limit	Sets the peak current limit for the motor. Used to protect the motor from large current commands. Do not operate amplifier in a current limit; this is for protection only. Range = 0- 20 Amps.
PWM Limit %	Sets the pulse width modulation limit for the motor. Used for limiting the average voltage applied to the motor. Range = 0 - 97%
Commutation Mode:	Selects a commutation mode for the motor.
Sinusoidal	Used wirth ACBL motors (Requires encoder on motor, Halls optional, but recommended.)
Trapezoidal	Used with BLDC motors. (Requires Hall sensors on motor.)
Micro-Stepping	The output of the trajectory generator is used to calculate the phase angle. This angle is used to generate sinusoidally varying outputs to each motor phase.
Phasing Based:	Selects a type of phasing for the motor.
Hall-Based	Used with sinusoidal or trapezoidal commutation. Requires Hall sensors.
Algorithmic	Used with sinusoidal commutation. (Initialization routine required, Halls not needed.)
Phase Counts	Counts per electrical cycle, or counts per pole pair.
Phase Correct Mode	When enabled, the encoder index signal is used to update the commutation phase angle for each motor revolution.
Phase Prescale	Divides in number of encoder counts by 64 (for long moves with a large number of encoder counts). Default = Off.

Parameter	Note(s)
Hall States	Displays inversion , if any, for Hall states. W, V, U.
Encoder Polarity:	Timing of index pulse relative to endoder counts.
___--___	Normally Lo with a HI transition.
--___--	Normally HI with a LO transition.
A+B = Index:	Timing of index pulse relative to encoder counts.
00	A Lo B Lo with index pulse Hi.
01	A Lo B Hi with index pulse Hi.
10	A Hi B Lo with index pulse Hi.
11	A Hi B Hi with index puose Hi.
Temp Sensor:	Check box if temperature sensor implemented.
Hi	Hi temperature threshold. Upper limit less than or equal to +5V.
Lo	Lo temperature threshold. Lower limit greater than or equal to 0V.
Reference Gain:	Reference command multiplyer. Default = 1 Range = 0.01 to 15

Table 5-10 Motor Data Parameters

Digital Position Input

You use the **Digital Position Input** pull-down menu (Figure 5-15) in **Gearing** mode to select a command signal to drive the amplifier. The **Input Source** may be: **A/B Quadrature Encoder, Pulse** and **Direction** (such as stepper commands), **Clockwise** or **Counterclockwise**.

Polarity may be **NonInverting** or **Inverting.**

Gear Ratio is used to set the number of input pulses to the same count as the number of output pulses on the motor. 65536 equals a 1 to 1 count. Value = (slave counts\master counts) x 65336.

To enter a value in the **Gear Ratio** field, position the cursor over the field and left click once. The **Gear Ratio** window should open. The **Digital Input** field sets the pulses for the Master Amplifier, while the **Amp Motor** field sets the number of output pulses for the Slave Amplifier.

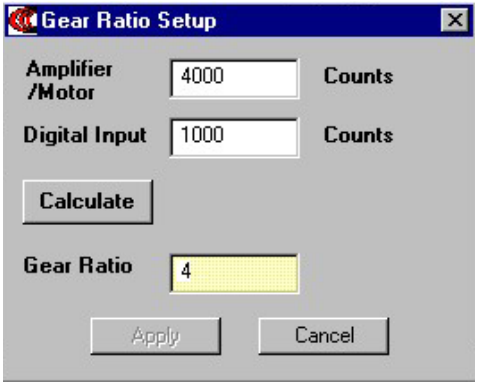


Figure 5-15 Digital Position Input

Analog Monitor

The **Analog Monitor** pull-down menu configures the analog output to monitor a specified signal (Table 5-11).

The **Multiplier**, in **Gearing** mode for example, can be used to amplify a small monitored signal.

The Offset can be +/- 10 volts.

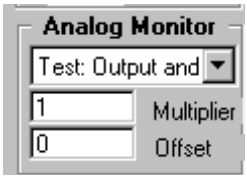


Figure 5-16 Analog Monitor

Note: The monitored signal is adjusted before writing to the Digital-to-Analog Converter as follows:

For 32 bit signals: Output = (signal + (offset x 2^{16})) x multiplier).

For 16 bit signals: Output = (signal + offset) x 2^{16} x multiplier).

In Table 5-11, signals are 32 bits, unless denoted as "winding 1", "winding 2", or "clipped".

Parameter	Notes
Analog Monitor: Test Output and	
None	No signal is selected. The DAC output will only reflect the offset and multiplier. (This may be used to test the DAC output.)
Commanded Position	The commanded position (units of encoder counts) .
Actual Position	The actual position as read from the encoder (units of encoder counts).
Position Error	The difference between the commanded and actual position (encoder counts).
Commanded Velocity	The commanded velocity (encoder counts/(cycle*2^{16})).
Actual Velocity	The actual velocity (encoder counts/(cycle*2^{16})).
Commanded Torque	The commanded motor torque.
Commanded Current (Winding 1)	Commanded current for winding 1 (after commutation.). Max. = 25A/10V, multiplier = 1.
Commanded Current (Winding 2)	Commanded current for winding 2 (after commutation.). Max. = 25A/10V, multiplier = 1.
Actual Current (Winding 1)	Actual current for winding 1 as read from the A/D converter. Max. = 25A/10V, multiplier = 1.
Actual Current (Winding 2)	Actual current for winding 2 as read from the A/D converter. Max. = 25A/10V, multiplier = 1.
Current Error (Winding 1)	Difference between the actual and commanded current for winding 1. Max. = 25A/10V, multiplier = 1.
Current Error (Winding 2)	Difference between the actual and commanded current for winding 2. Max. = 25A/10V, multiplier = 1.
Output Command (Winding 1)	Output of current loop for winding 1. Max. = 25A/10V, multiplier = 1.
Output Command (Winding 2)	Output of current loop for winding 2. Max. = 25A/10V, multiplier = 1.

Parameter	Notes
Analog Monitor: Test Output and	
Phase Angle	Phase angle used for commutation. Range is 0 to (Phase Counts -1).
Commanded Position (clipped)	The commanded position (units of encoder counts)clipped to 16 bits.
Actual Position (clipped)	The actual position (units of encoder counts) clipped to 16 bits.
Position Error (clipped)	The difference between the commanded and actual position (encoder counts) clipped to 16 bits.
Commanded Velocity (clipped)	The commanded velocity (encoder counts/(cycle*2^{16}) clipped to 16 bits.
Actual Velocity (clipped)	The actual velocity (encoder counts/(cycle*2^{16}) clipped to 16 bits.
Runing Current Summary	The sum of the differences between the commanded torque squared and the torque threshold squared. This is the sum that is compared ti the programmable current limit.
Running Current Summary (clipped)	Same as above, but clipped to 16 bits for better resolution.

Table 5-11 Analog Monitor Signals

Status Outputs

On the **Amplifier Status Now!** screen, there is a segment (Figure 5-17) that lets you program the Status Outputs lines — from the Amplifier to be read on pendant.

You can program the pendant indicators **STAT-0** and **STAT-1** to indicate whether a motion profile is active or a fault has occurred. Select the **Status Output** button to open the **Status Output** screen. Check the appropriate status box, **True/False** button and **On (Hi/LO)** option.

STAT-0 and **STAT-1** have mask and sense bytes (Hex). Mask data is sent to the amplifier. Sense data is read from the amplifier.

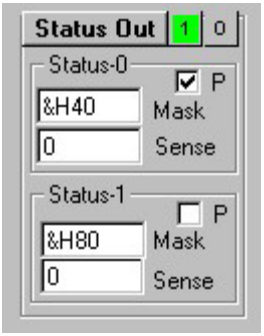


Figure 5-17 Status Outputs Screen Segment

Preset Manager Screen

On the **Main** menu, select **Amplifier > Preset Manager** to display the **Preset Manager** screen (Figure 5-18).

The **Preset Manager** screen displays amplifier and motor data associated with parameters for a selected preset (0-15). *A preset is an instance of all the necessary motor and amplifier data necessary to make a motor perform a predefined task.*

When you select **Preset Manager**, Preset 0 displays in the screen by default. The screen displays all the parameters described earlier under **Amplifier Status Now!** screen. In addition the screen has buttons (Table 5-12) to facilitate management of the presets.

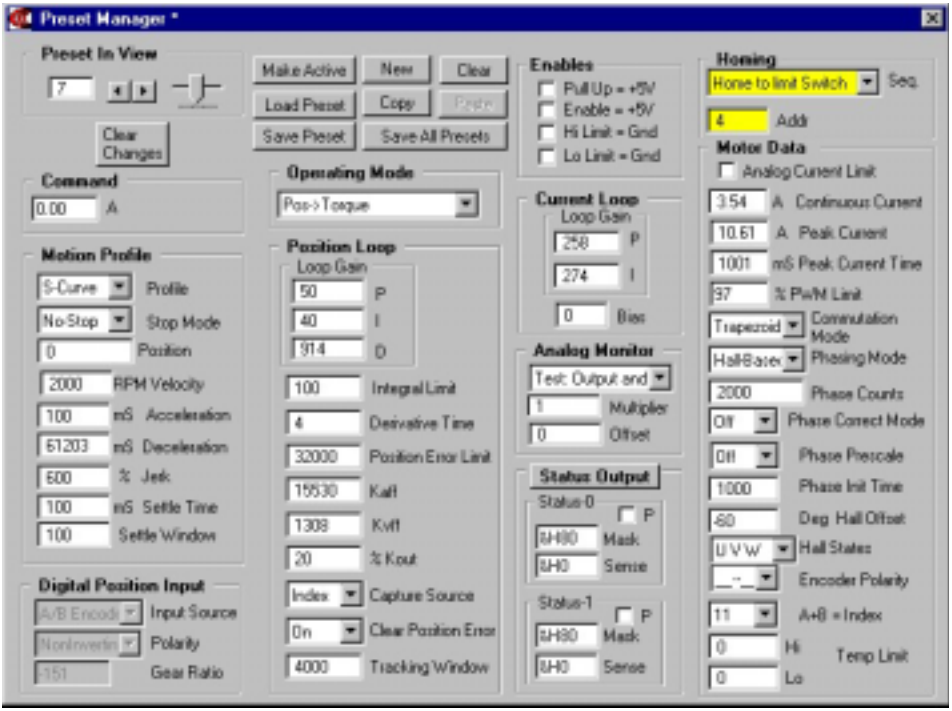


Figure 5-18 Preset Manager Screen

Button	Function
Make Active	Loads the **Preset In View** to both *temporary and fllash memory* in the amplifier. Make Actrive has the same effect as enabling a preset switch on the pendant.The software will ask you to disable the amplifier in order to perform this task.
New	Loads the preset manager with the current values from the **Amplifier Status Now!** screen.
Clear	Clears all the values in the current preset.
Interrogate	Uploads a preset from the amplifier to RAM in the PC.
Copy	Makes a copy of the existing preset screen, which you may paste into another preset screen.
Paste	Pastes a copy of a preset screen into another preset screen.
Download	Download the **Preset In View** to flash memory on the amplifier.
Download All	Download all presets (0-15) to flash memory on the amplifier.
Homing	Only available with preset 15. See the section that follows this table.

Table 5-12 Preset Manager Screen Buttons

Motor Menu

On the **Main** menu (Figure 5-21), the **Motor** pull-down menu has three options: **Motor Data, Motor Temp. Sense and Select.**

Figure 5-21 Main Menu

Motor Data Screen(s)

When you select **Motor Data**, the **Motor Data Specification** screen, which contains a series of tabs used to access other screens, is displayed (Figure 5-22). Motor **Type** is the first screen displayed.

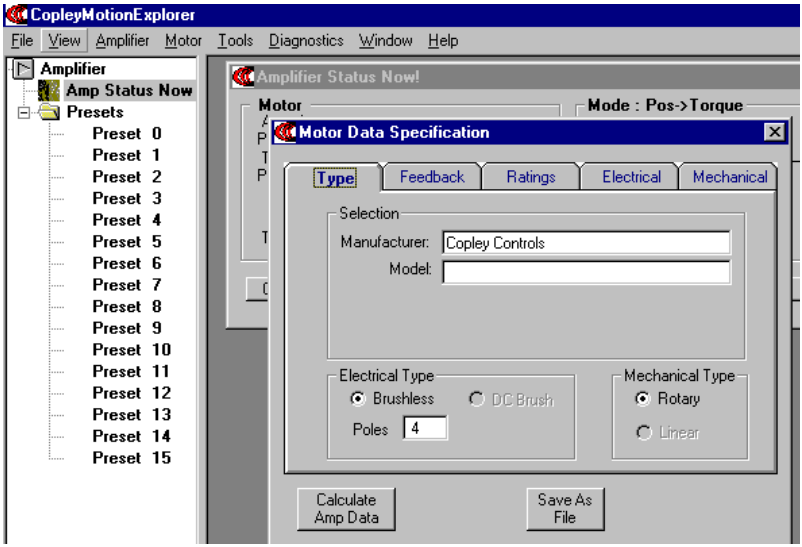


Figure 5-22 Motor Data > Specification > Type Screen

Note: The parameters captured in the motor data screens reflect selection of **Mechanical Type, Rotary**. **Linear** parameters are documented under each **Motor Data** screen in the section that follows.

Motor Data > Specification Type Screen

On the **Motor Data > Specification > Type** screen (Figure 5-21), you can input information about the motor's manufacturer , model and type.

On this screen brushless is defined as: *a sinusoidally or trapezoidally wound, wye or delta connected brushless motor.*

Two buttons — **Calculate Amp Data** and **Save As File** — are also important to retaining amplifier parameters. See the *next* section.

Motor Data > Specification > Feedback Screen

Enter motor data on this screen, if you are manually entering your motor specification in order to calculate amplifier parameters.

On this screen, use the encoder data sheet to determine the number of **Encoder lines**. Typical Encoder lines values are 500, 1000, 1024, etc. During the Encoder Check Routine (Chapter 3), CME multiplies the number of Encoder lines found by four, to determine encoder counts — per revolution of the motor shaft.

If the motor has an index signal, check **Index**. Then select the relative timing of the index pulse. *If the index is 1/4 of a line, select the correct location. Example, Index Hi when A and B are Hi.*

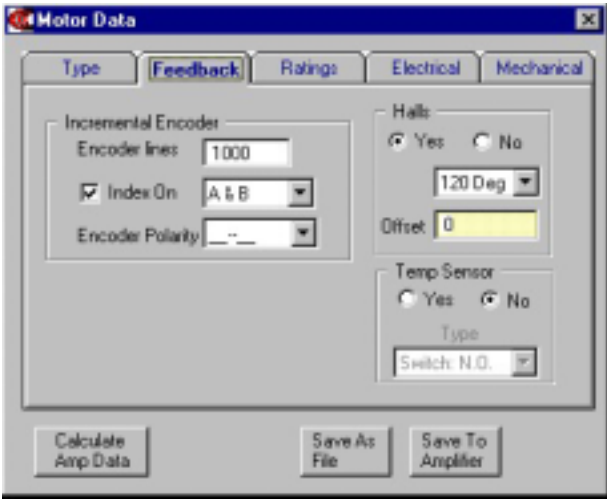


Figure 5-23 Motor Data > Specification > Feedback Screen

Linear Parameter(s)

Linear Encoder Resolution: um
Magnetic Pair Length: mm

*Save data as described earlier in this **Motor** menu section.*

Motor Data > Specification > Ratings Screen

If you are manually entering your motor specification in order to calculate amplifier parameters enter your motor data on this screen

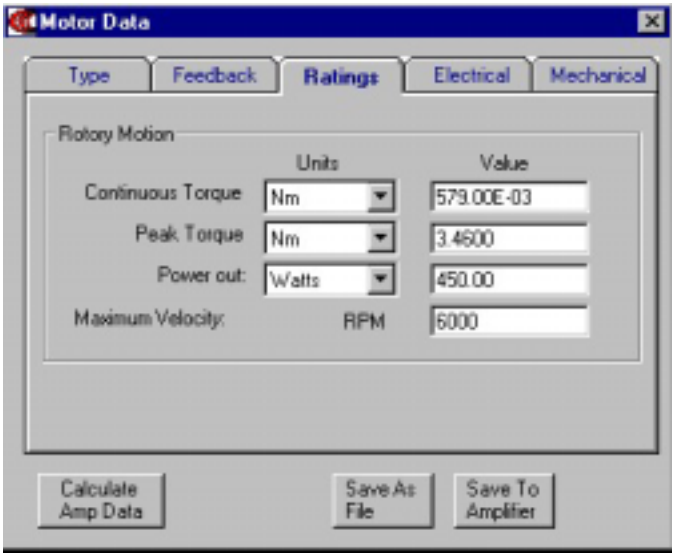


Figure 5-24 Motor Data > Specification > Ratings Screen

Linear Parameters

Linear Continuous Force: N, Lb or 0z.

Linear Peak Force: N, Lb or 0z.

*Save data as described earlier in this **Motor** menu section.*

Motor Data > Specification > Electrical Screen

Enter motor data on this screen, if you are manually entering your motor specification in order to calculate amplifier parameters.

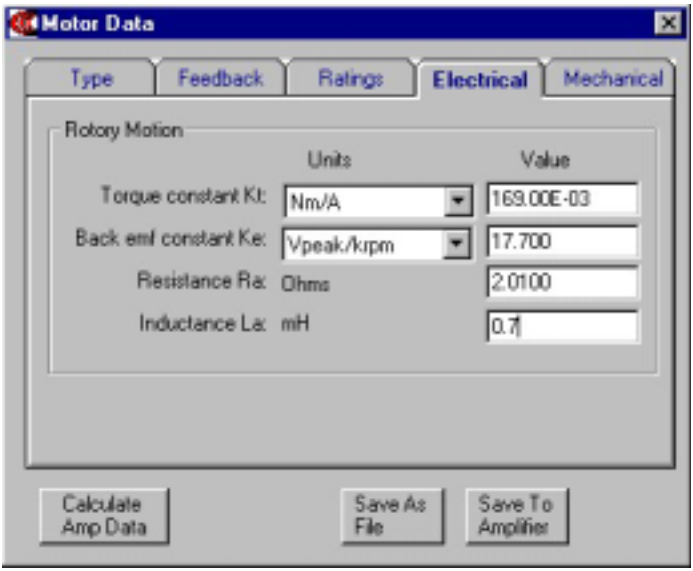


Figure 5-25 Motor Data > Specification > Ratings Screen

Linear Parameters

Linear Force Constant: N, Lb or 0z.

Linear Back emf Constant: V/mm, V/in

*Save data as described earlier in this **Motor** menu section.*

Motor Data > Specification > Mechanical Screen

If you are manually entering your motor specification in order to calculate amplifier parameters enter motor data on this screen

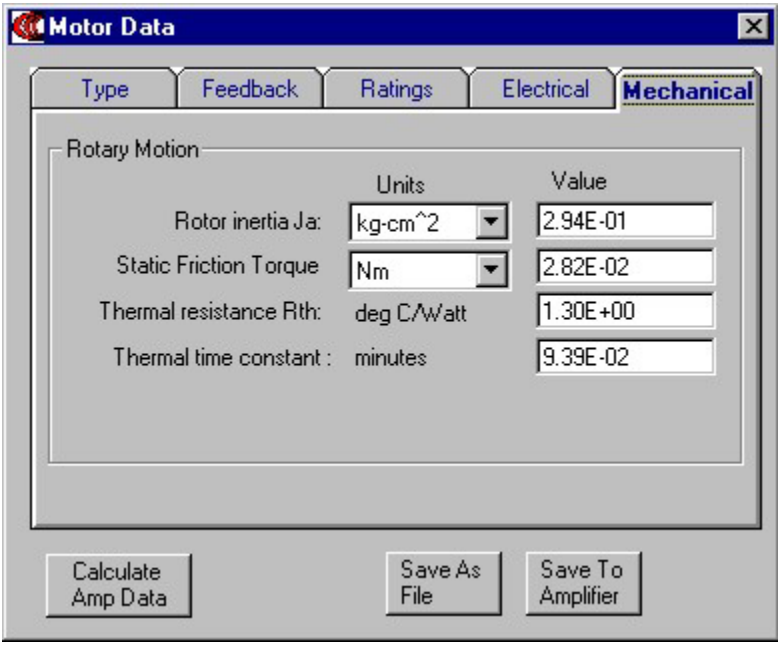


Figure 5-26 Motor Data > Specification > Mechanical Screen

Linear Parameters

Linear mass: Kg, Lb, 0z.

Linear Static Friction: Kg, Lb, 0z.

*Save data as described earlier in this **Motor** menu section.*

Calculate Amplifier Data Button

If you've input motor parameters to a **Motor Data Specification** screen, **Type** for example, and you want to use this data — and the data on the *other* **Motor Data Specification** screens:

1. Selecting **Calculate Amp Data** to generates model amplifier parameters.

Note: To fully generate amplifier parameters, you must input data to each of the **Motor Data Specification** screens — **Type, Feedback, Ratings, Electrical** and **Mechanical.**

---

2. The **CME** software models the data you've input, then displays the recommended parameters on the **Apply Motor Data** screen (Figure 5-27).

Save As File button

Use the **Save As File** button to save the motor data as a Copley Controls Motor (.ccm) file.

Apply to Amp Status Buttons

When you select an **Apply to Amp Status** button, the motor data is *applied* to the **Amplifier Status Now!** screen. Using the **Amplifier Status Now**! screen temporarily load the data into the amplifier's volatile memory or permanently into the flash memory.

Apply Motor Data Screen

You use **CME** to access this screen (Figure 5-27) if you are:

a. Manually inserting motor specifications into the **Motor Data Specification** screens.

b. Uploading a .ccm file automatically inserts motor data into the **Motor Data Specification** screen.

When you select **Calculate Amp Data**, **CME** software *models* the data and displays the results in the **Apply Motor Data** screen.

Note: The parameters on this screen are detailed in the previous section describing the **Amplifier Status Now!** screen.

Tuning Slides

The **Apply Motor Data** screen has tuning slides (Figure 5-27). You can use the slides to adjust the results of the data modeling. The tuning slides affect **Current** and **Position Loop**. The parameters associated with the slides — **Bandwidth, Stiffness** etc. — also have values resultant of the modeling process. *Increment the slides and check system response.*

Slide	Function
Current Loop:	
Bandwidth	Used to increase or decrease the current loop response. If proper values for motor inductance and resistance are entered, the default current loop response is typically > 1kHz.
Peaking	Used to affect the amount of overshoot of the current loop response. Typical peaking is about 5%. The default current loop valuse calculated by the model are highly reliable, so it is not necessaary to change them.
Position Loop:	
Bandwidth	Used to change the system bandwith as it affects PID values, ""I" and "D" mainly.
Gain	Used to change the overall system gain by affecting the Kout term.
Stiffness	Used to change system stiffness by affecting the "P" term.
Integrator	Used to change the amount of inttegration, "I" term.
Kaff	Used to change the acceleration feed forward by affecting the Kaff term. Used to reduce position error during acceleration.
Kvff	Used to change the velocity feed forward fy affecting the Kvff term. Used to reduce position error during velocity.

Table 5-13 Tuning Slides

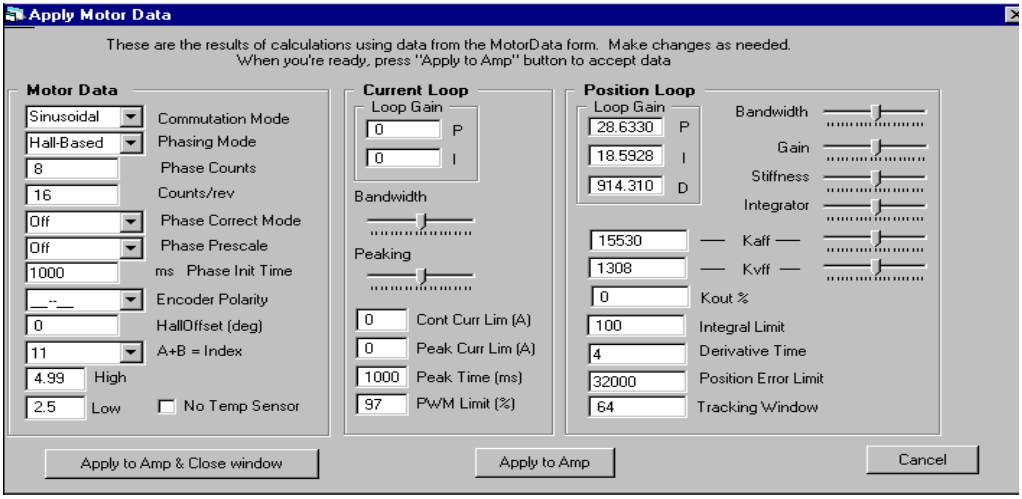


Figure 5-27 Apply Motor Data

Motor Temperature Sensor Screen

From the **Motor** drop-down menu, you can access the **Motor Temperature Sensor** screen. Use the adjustable slides to set upper and lower temperature thresholds.

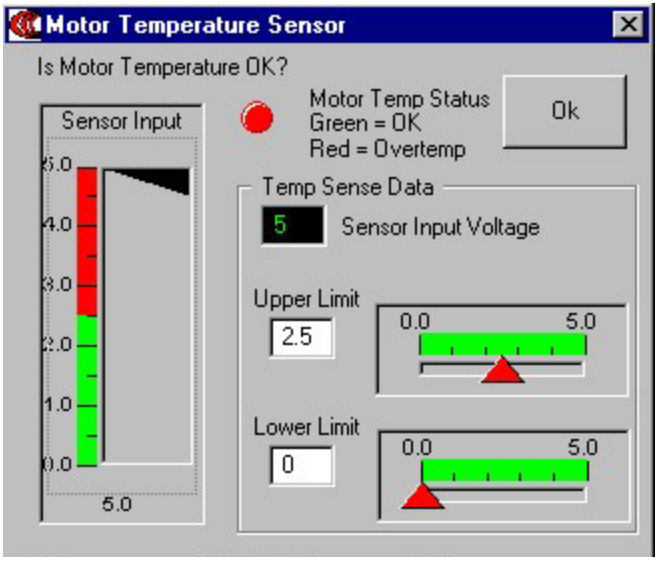


Figure 5-28 Motor Temperature Sensor Screen

Selecting **Tools** from the **Main** menu, provides access to the following features: **Trace Graph, Options, Download Firmware and Encoder Check.**, **Auto Phasing and Home**.

Tools > Trace Graph

This feature lets you select parameters (Figure 5-29) to trace in real-time on the **Performance Trace** screen (Figure 5-30).

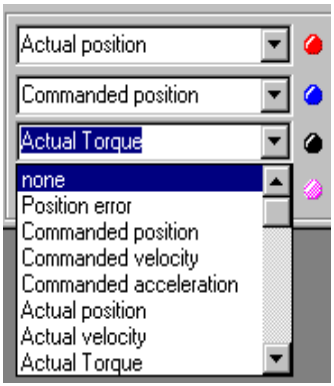


Figure 5-29 Trace Parameters

You can select up to four parameters to trace at a time. Each one is represented on the trace screen by the color adjacent to your selection.

Selecting **Immediate** displays consistently refreshing trace parameters. Selecting **Update** displays trace parameters after an update command or after applying a change.

Selecting **Arm** initiates a trace. Selecting **AutoArm** *repeatedly* initiates a trace.

Select **Torque** displays a second chart representing U and V current on the X and Y axis.

Selecting **Buffer Size** sets the number of samples.

Selecting **Interval** re-initiates (and re-displays) traces at regular time intervals.

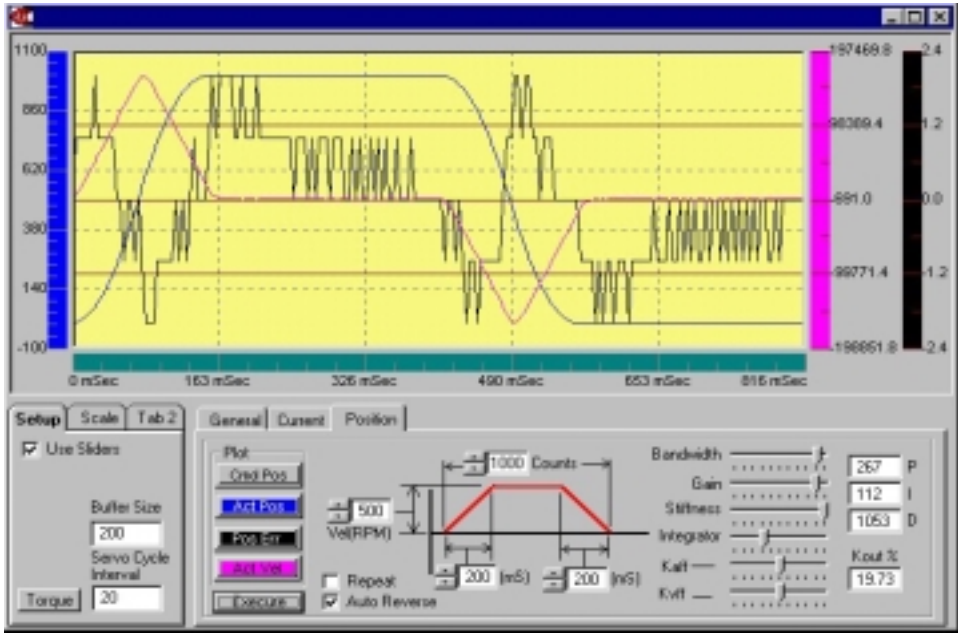


Figure 5-30 Performance Trace Screen

Tools > Options

On the **Tools** menu, select **Options** to access the following features: **Communications, Directories** and **Advanced**.

Tools > Options > Communications Screen

As with the **On-Line Connection** screen, the **Communications** screen lets you select a default port and baud rate for communications between the amplifier and a PC or laptop.

Check box controls allow let you to select **Automatic Connect on Startup** and **Status Query**. Status Query is the same as Status Update on the **Amplifier Status Now!** screen.

When you select Status Query and **Update Rate**, you are asking **CME** to interrogate the amplifier at a specified rate and display status in the **Amplifier Status Now!**

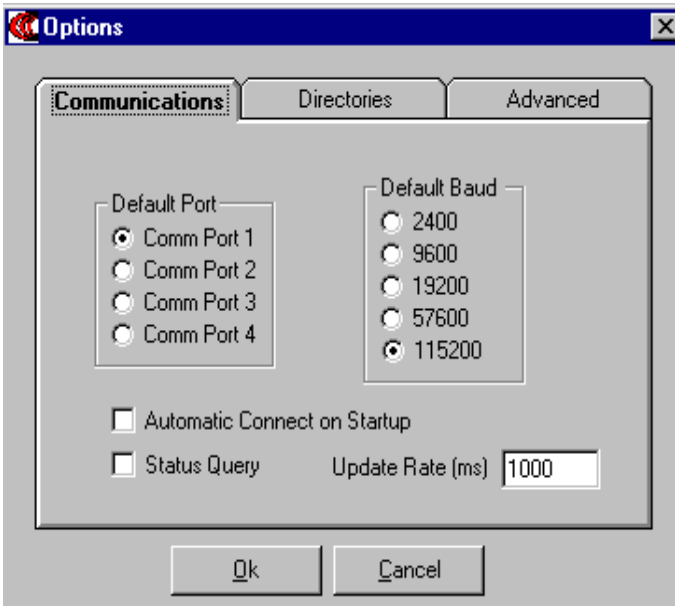


Figure 5-31 Options > Communications Screen

Tools > Options > Directories

The Directories screen shows the location of, and allows access to, various amplifier and motor files.

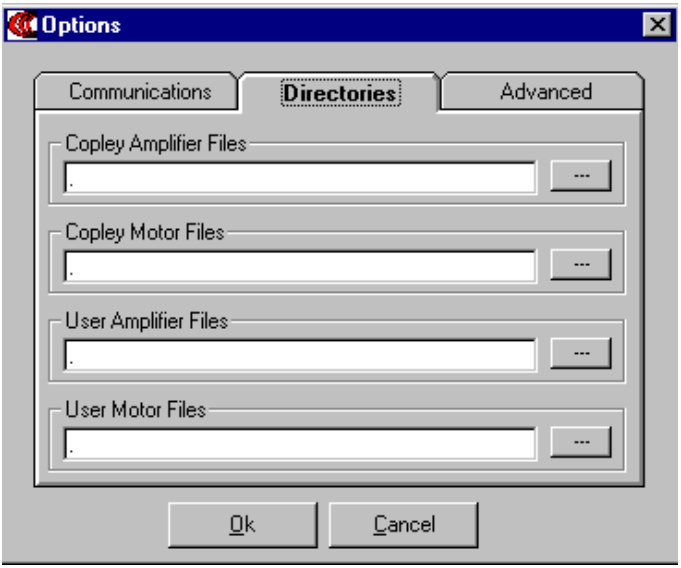


Figure 5-32 Options > Directories Screen

Tools > Options > Advanced

When you select Help > Copley on the Web, **CME** uses the address here to access the Copley Controls Web site.

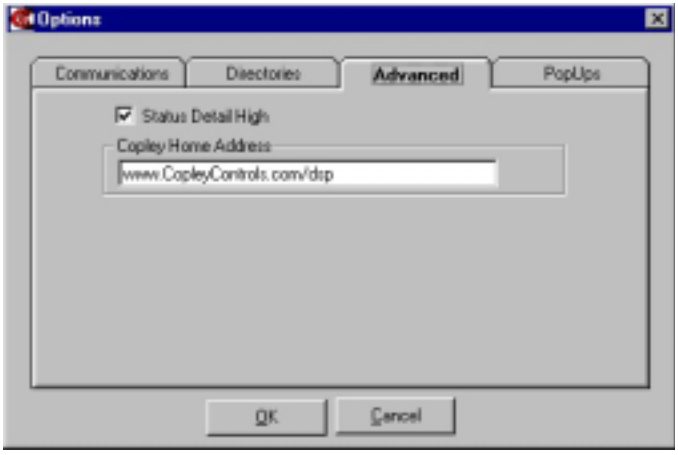


Figure 5-33 Options > Advanced Screen

Tools > Download Firmware

In the future, new features and enhanced functionality may be implemented in the amplifier's firmware. When you receive a firmware release from Copley Controls, save it to the ***Copley Motion Explorer™*** folder.

You can use ***Copley Motion Explorer™*** to update firmware:

1. From the **Tools** menu, select **Download Firmware**.
2. Select the **cplyXXXX.bin** file that contains the latest firmware.
3. Selecting **Open** displays the message "**Erasing**" (old firmware). A bar graph, which signifies the new firmware is being loaded, is displayed. When the bar graph is full, the update is complete.
4. At the **Main** menu, verify the firmware version. Select the **Amplifier > Connect to Host.**

Note: At the end of the download routine, the amplifier is reset. The Baud Rate changes to 9600, which results in a loss of communication if any other Board Rate was originally selected. Reconnecting returns the Borad Rate to the desired value.

Warning: If communication is lost while downloading firmware, the amplifier must be returned to the factory.

Tools > Encoder Check

Select **Tools > Encoder Check** to access the **Encoder Check** screen (Figure 5-34).

The Encoder Checking routine verifies the integrity of the motor's encoder as follows:

- Checks for the presence of encoder quadrature pulses.
- Verifies the presence of an index pulse.
- Verifies that you have selected the correct A and B signal synchronization to the index pulse.
- Aids you in verifying the number of encoder lines.

Perform the **Encoder Checking** routine before attempting to auto phase a new motor. Also, use this routine if you suspect problems with your encoder.

See *Encoder Checking* in Chapter 3 for details on executing the encoder checking routine.

Figure 5-34 Encoder Check Screen

Tools >Auto Phasing

Select **Tools > Auto Phasing** to access the **Auto Phasing** screen (Figure 5-35).

Usually you use the **Auto Phasing** routine when wiring a new vendor motor to the amplifier. You can use the **Auto Phasing** routine to phase Hall sensors, the encoder and motor output wires. Execution of the routine enables you to achieve proper phasing for sinusoidal and trapezoidal commutation.

See the *Auto Phasing* section in Chapter 3 for details on executing auto phasing.

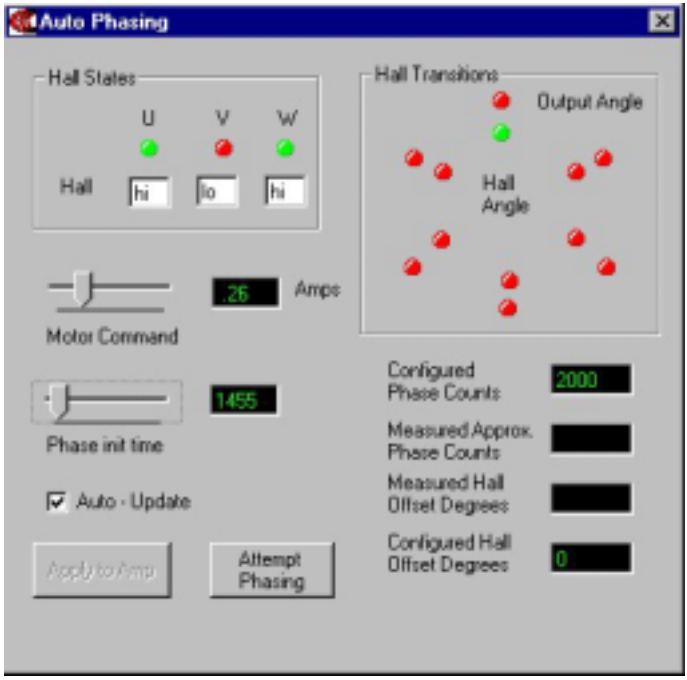


Figure 5-35 Auto Phasing Screen

Tools > Homing Sequence

The options available for the Homing Sequence are described in *Chapter 3*, **Homing Sequence**.

Diagnostics Menu

The Diagnostics menu contains the features: **Amp OK, Trace, Comm Log, Groups** and **Special**.

You do not have access to the **Amp Ok, Trace** and **Group** items. They are for use by Copley Controls personnel.

Diagnostics > Comm Log > Communication Log

When you check **Enable Logging** *(and follow some other steps described below),* this screen (Figure 5-36) displays various communications messages including:

- the command, Level 0 or Level 1,
- type of message: **INFO, WARNING, ERROR**.

The commands you can monitor in the **Communiuctions Log** screen are described as two levels: Level 0 Level 1.

When selected, Level 0 commands that display (Figure 5-36) are instruction mnemonics that describe the machine language commands in ***Copley Motion Explorer™***

Instructions are 16 bit words; the first eight bits consist of the hexadecimal code that represents the instruction.

For example in Figure 5-36, notice the (Sent:) **Get Acceleration** command. It's hexadecimal representation is 4C. The **Get Acceleration** command reads the data in the **Acceleration** parameter (under **Motion Profile** on the **Amplifier Status Now!** screen) — for the preset that is currently selected.

Note: To display commands in the **Communications Log** screen, check Level 0. Then you must also access the **Amplifier Status Now!** screen and select **Status Updates**.

When selected, Level 1 commands are Get Presets (hexadecimal representations of the active preset). To display Level 1 commmands you must open the **PreSet Manager** screen, **Select** a **Preset in View,** select **Make Active** and select **Interrogate.**

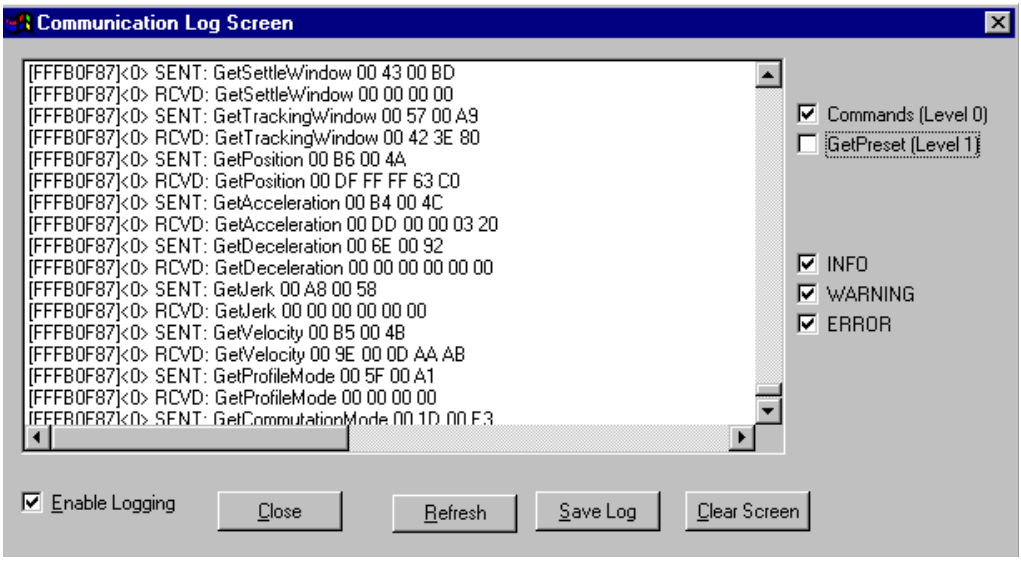

Communication Log Screen
[FFFB0F87]<0> SENT: GetSettleWindow 00 43 00 BD
[FFFB0F87]<0> RCVD: GetSettleWindow 00 00 00 00
[FFFB0F87]<0> SENT: GetTrackingWindow 00 57 00 A9
[FFFB0F87]<0> RCVD: GetTrackingWindow 00 42 3E 80
[FFFB0F87]<0> SENT: GetPosition 00 B6 00 4A
[FFFB0F87]<0> RCVD: GetPosition 00 DF FF FF 63 C0
[FFFB0F87]<0> SENT: GetAcceleration 00 B4 00 4C
[FFFB0F87]<0> RCVD: GetAcceleration 00 DD 00 00 03 20
[FFFB0F87]<0> SENT: GetDeceleration 00 6E 00 92
[FFFB0F87]<0> RCVD: GetDeceleration 00 00 00 00 00 00
[FFFB0F87]<0> SENT: GetJerk 00 A8 00 58
[FFFB0F87]<0> RCVD: GetJerk 00 00 00 00 00 00
[FFFB0F87]<0> SENT: GetVelocity 00 B5 00 4B
[FFFB0F87]<0> RCVD: GetVelocity 00 9E 00 0D AA AB
[FFFB0F87]<0> SENT: GetProfileMode 00 5F 00 A1
[FFFB0F87]<0> RCVD: GetProfileMode 00 00 00 00
Commands (Level 0)
GetPreset (Level 1)
INFO
WARNING
ERROR
Enable Logging
Close
Refresh
Save Log
Clear Screen

Figure 5-36 Diagnostics Comm Log Screen

Diagnostics > Special> DSP Commands

Selecting **Diagnostics > Special** > **DSP Commands** displays the **Copley DSP Commands** screen (Figure 5-37). You can use the DSP command pull-down menu on this screen to select a specific command and send it to the amplifier. You can read the commands hex code (low byte), which is initially displayed in a grey box.

In conjunction with the **Communication Log** screen, (Figure 5-38), you can verify that specific commands are sent and received. Select **Enable Logging** to display data.

Many of the Set Commands are buffered. Buffered commands must be followed by the update command to take effect. For more information, see the 7XX8 Series of Digital Servo Amplifier Programmer Reference Manual.

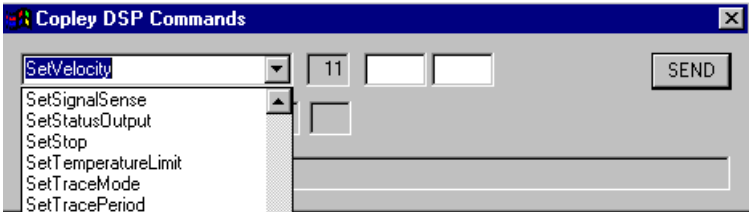


Figure 5-37 Copley DSP Commands

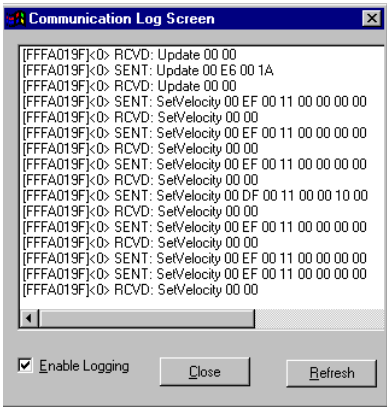

Communication Log Screen
[FFFA019F]<0> RCVD: Update 00 00
[FFFA019F]<0> SENT: Update 00 E6 00 1A
[FFFA019F]<0> RCVD: Update 00 00
[FFFA019F]<0> SENT: SetVelocity 00 EF 00 11 00 00 00 00
[FFFA019F]<0> RCVD: SetVelocity 00 00
[FFFA019F]<0> SENT: SetVelocity 00 EF 00 11 00 00 00 00
[FFFA019F]<0> RCVD: SetVelocity 00 00
[FFFA019F]<0> SENT: SetVelocity 00 EF 00 11 00 00 00 00
[FFFA019F]<0> RCVD: SetVelocity 00 00
[FFFA019F]<0> SENT: SetVelocity 00 DF 00 11 00 00 10 00
[FFFA019F]<0> RCVD: SetVelocity 00 00
[FFFA019F]<0> SENT: SetVelocity 00 EF 00 11 00 00 00 00
[FFFA019F]<0> RCVD: SetVelocity 00 00
[FFFA019F]<0> SENT: SetVelocity 00 EF 00 11 00 00 00 00
[FFFA019F]<0> SENT: SetVelocity 00 EF 00 11 00 00 00 00
[FFFA019F]<0> RCVD: SetVelocity 00 00
Enable Logging
Close
Refresh

Figure 5-38 Set Velocity Sent and Received

The Window menu provides you with standard Window controls: **Cascade, Tile Horizontal, Tile Vertical, Arrange Icons** and **Amplifier Status Now!**.

Help Menu

The **Help** menu provides you with on-line Help for the ***Copley Motion Explorer™*** software. Some *limited* Help is available as of this printing. From the **Main** menu, select **Help > Contents** to open the help files.

Help > About

On the **Main** menu, select **Help > About** to display the software release version of ***Copley Motion Explorer™*** (Figure 5-39).

Select Information About to display Microsoft System Information (Figure 5-40).

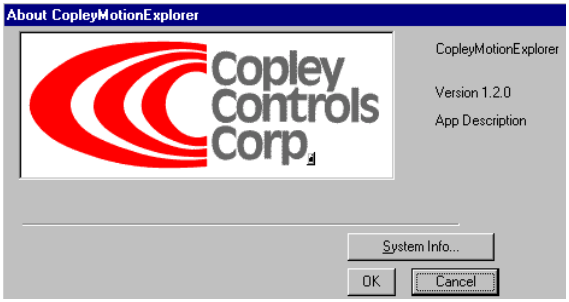


Figure 5-39 About Copley Motion Explorer

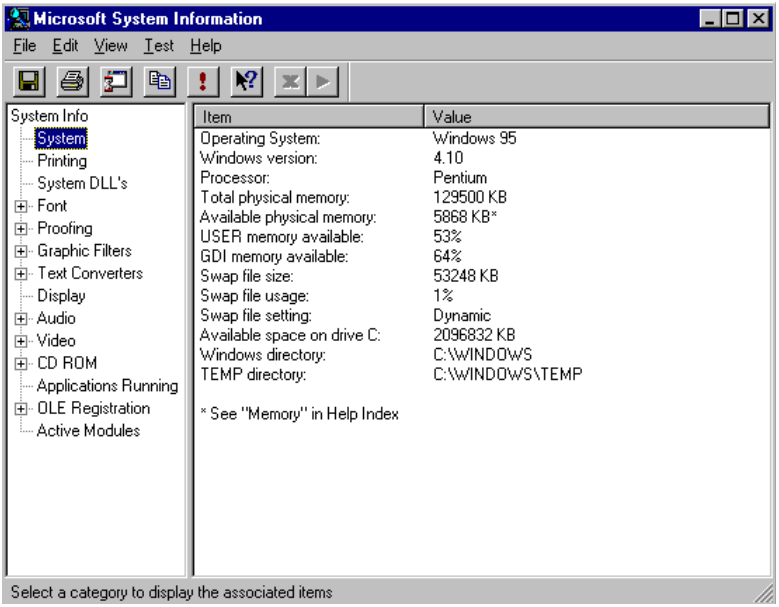


Figure 5-40 Microsoft System Information Screen

Amplifier Explorer Window

This window (Figure 5-41), displayed to the left of the **Main** window, contains icons for **Amplifier Status Now!** and each of the 0-15 presets. Selecting an icon opens the **Amplifier Status Now!** screen or a **Preset Manager** screen for a specific preset.

View > Explorer, located on the **Main** menu, acts as a toggle control for the **Amplifier Explorer Window** and determines if the window is open (viewed) or closed (not viewed).

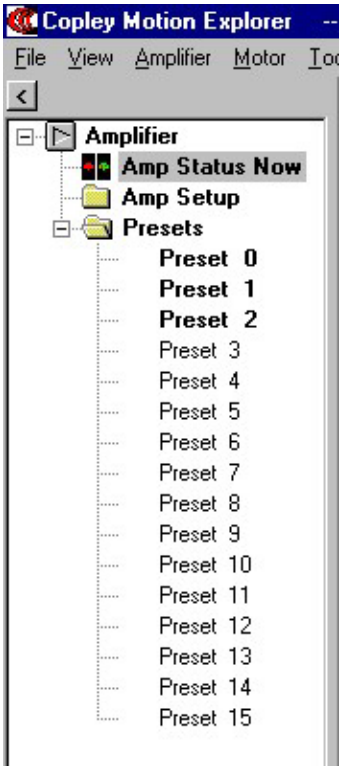


Figure 5-41 Preset Select Window

Stop Motor Window

Use the **Stop Motor** window (Figure 5-42) to halt a motor. If you close this window, you must restart **CME** to re-display it.

Selecting **Stop Motor** overrides the **Enable Overide** indicator/button on the **Amplifier Ok** screen. If **Enable Overide** is red, slelect it and then select **Clear Enable Overide**.

Figure 5-42 Stop Motor Window

Copley Virtual Machine (CVM)

The CVM is a program area that stores and runs CVM Programs. The Standard CVM Program is used by the Copley 7xx8 Amplifier to perform the homing function. If a sequence is selected, in a particular preset (see figure 5-43), the CVM program will run the selected function after the preset is loaded.

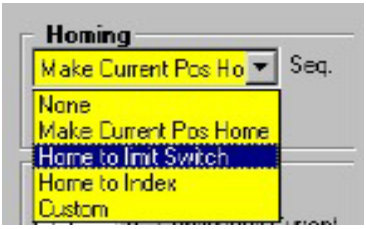


Figure 5-43 CVM Sequence selection

When the CVM program is running, the program counter and CVM status can be viewed on the **Amplifier Status Now!** screen. To stop a CVM program while it is running press the **Stop** button (see figure 5-44).

Figure 5-44 CVM monitor

The Standard CVM Program, loaded by the factory, contains the homing routines. The Standard CVM Program can be loaded by the user, from the file menu, by selecting load CVM and selecting the appropriate *filename*.cvm file. See the user guide for details on how to use the homing routines.

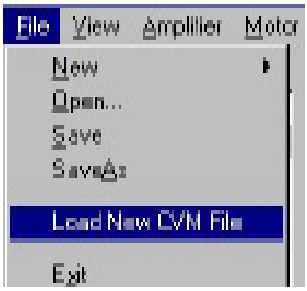


Figure 5-45 Loading CVM

Custom CVM Programs may be documented and available for use by qualified customers. New CVM Programs can be loaded by the user, from the file menu, by selecting load CVM and selecting the appropriate CVM file. If the custom sequence is selected, in a particular preset, it will run after the preset is loaded. See the associated document with the Custom CVM Program being used, for details.

NOTES

Appendix A Technical Specifications

The technical specifications were generated under the following test conditions: 25 degrees C ambient, Load = 400 µH in series with 1 Ohm.

Model	**7228AC**	**7428AC**
Output power:		
Peak power	20A @ 110VAC	20A @ 205VAC
Peak time	1 second at peak power or 2 seconds after polarity reversal.	
Continuous power	10A @ 130VDC	10A @ 250VDC
Output voltage:		
On-resistance (Ro, ohms)	0.2	0.15
Max PWM Peak Output Voltage	(VAC x 1.41 -2) x (0.97) - (Ro) x (Io)	
Maximum effective output voltage at continuous power	130V @ 10ADC	250V @ 10ADC
Maximum effective output voltage at peak power	110V @ 20ADC	205V @ 20ADC

Model	7228AC	7428AC
Input Power:		
Mains Voltage	32~132VAC, 47~63Hz	32~132VAC, 47~63Hz
Mains current @ continuous output rating	16A	16A
Inrush current on startup	19A max	37A max
External mains fuse rating	20A/125V Time delay	20A/250V Time delay

Mechancial: Weight 3.71 lb (1.69kg) without optional heatsink. Add 3.2 lb (1.47kg) for heatsink.

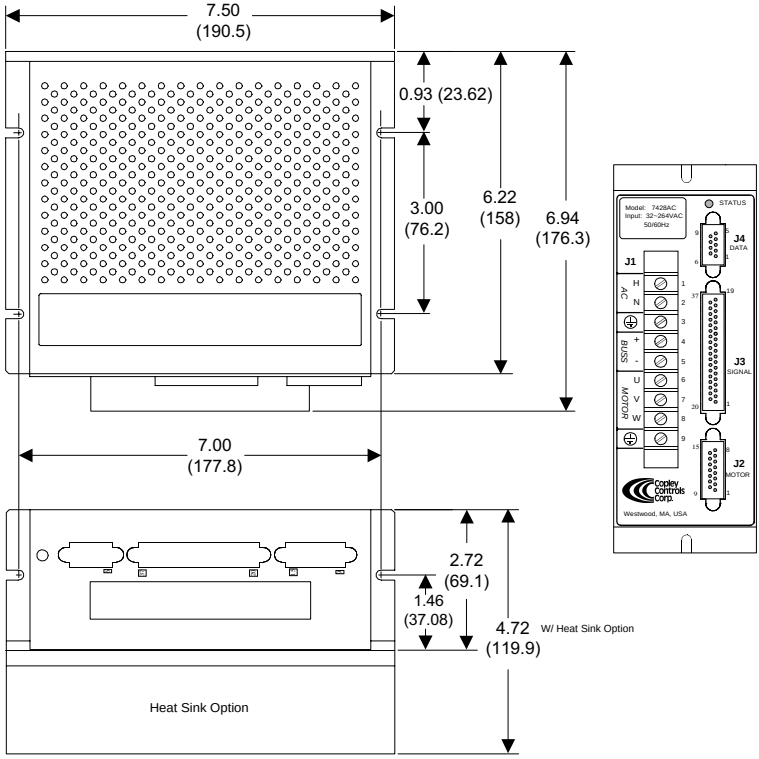


Figure A-1 Mechanical Outline AC Model

AC Model Connections

J1: Power and motor 9-position terminal strip.

J2: Motor 15-position female Sub-Dtype. #4-40 standoffs for cable shell lock. Use 15-pin Male Sub-D solder cup & backshell: AMP 747904-2 & 749915-2 or equivalent.

J3: Signal 37-position female Sub-D. #4-40 standoffs for cable shell lock screws. Use 37-pin Male-D solder cup & backshell: AMP 747916-2 & 749916-2 or equivalent.

J4: RS-232
9 position female Sub-D. #4-40 standoffs for cable shell lock screws. Use a 9-pin Male Sub-D solder cup & backshell: AMP 747904-2 & 749914-2 or equivalent.

Connector shells are connected to the amplifier chasis for grounding/shielding.

Model	**7228DC**	**7428DC**
Output power:		
Peak power	20A @ 180VDC	20A @ 370VDC
Peak time	1 second at peak power or 2 seconds after polarity reversal	
Continuous power	10A @ 180VDC	10A @ 370VDC
Output voltage:		
On-resistance (Ro, ohms)	0.2	0.15
Max PWM Peak Output Voltage	(HV) x (0.97) - (Ro) x (Io)	

Model	7228DC	7428DC
Input Power:		
High Voltage	45~186VDC	45~373VDC,
HV current @ continuous output rating	16A	16A
Inrush current on startup	19A max	37A max
External mains fuse rating	20A/125VDC Time delay	20A/250VDC Time delay

Mechancial: Weight 2.71 lb (1.23kg) without optional heatsink. Add 3.2 lb (1.47kg) for heatsink.

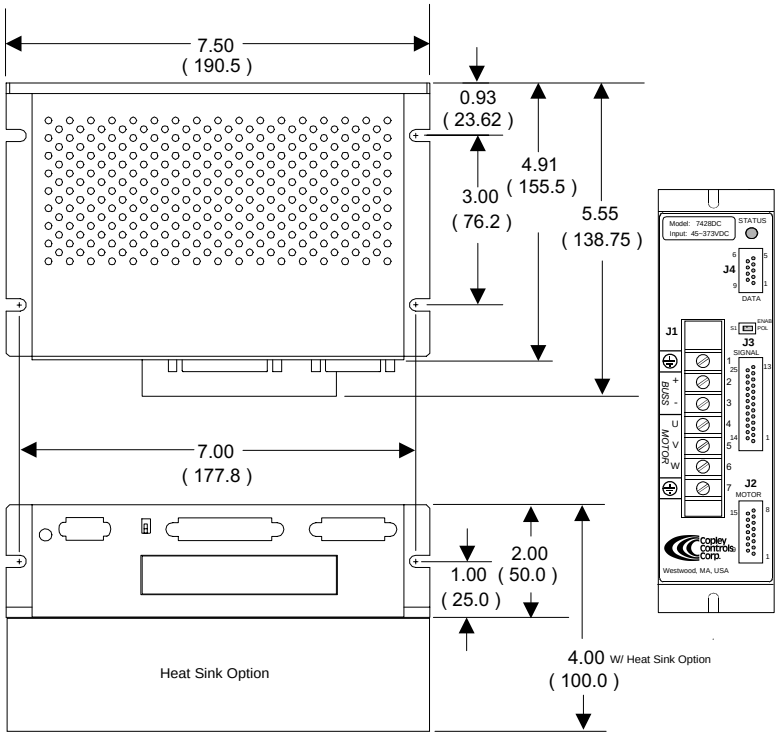


Figure A-2 Mechanical Outline DC Model

DC Model Connectors

J1:	Power and motor 7-position terminal strip.
J2:	Motor 15-position female Sub-Dtype. #4-40 standoffs for cable shell lock .Use 15-pin Male Sub-D solder cup & backshell: AMP 747904-2 & 749915-2.
J3: Signal	37-position female Sub-D. #4-40 standoffs for cable shell lock screws. Use 37-pin Male-D solder cup & backshell: AMP 747916-2 & 749916-2.
J4: RS-232	9-position female Sub-D. #4-40 standoffs for cable shell lock screws. Use 37-pin Male-D solder cup & backshell: AMP 747916-2 & 749916-2.

Other Technical Specifications for DSP Model 7XX8

Load inductance:

Minimum inductance	400µH
Maximum inductance	No maximum. Maximum varies with inductance and supply.

Bandwidth:

Small signal	-3dB @ 2kHz with minimum load at nominal supply voltage. Varies with load inductance and filter values.

PWM outputs:

PWM frequency	25kHz
Modulation	Center-weighted, 50% duty cycle at 0V output.

Reference inputs:

Torque or velocity	Analog ±10V. Differential 94KW between inputs, ±20V maximum.
Position	Digital, 2-signal. TTL, any of three formats: CW/CCCW, Pulse.Dir, A&B quadrature pulses.
Preset	Digital, 4 line. TTL 28V max. Group programmable: 22k Ohm internal pull-up to +5V or pull-down to 0V. The four inputs initiate 16 pre-defined prests.

Motor overtemp input:

Analog input	5kW internal pull-up to +5V, for thermistor or IC sensor.Thresholds programmable.

Logic Outputs:

Status output:	Two: Stat0, Stat1 Software function programmable. N-channel MOSFET, 10k pull-up to +5V, Max. 50V off-voltage. Max. 250mA sink, 5 Ohm On-resistance
Status LED:	Bi-color LED changes color and flashes to indicate amplifier operating status.
Blinking green	Ready, Amplifier OK. Amp. will run when *enabled.*
Green	Normal, Amplifier *enabled* and AMP OK.
Red	Buss fault, non-latching over or under-volage condition. Amplifier recovers when in normal range.
Blinking red	Latching fault. Output overcurrent (short circuit) or overtemp condition. Ground, /Reset or power amp. off/on to clear condition.
Analog monitor:	+/-10V full scale, 1k Ohm source resistance. Programmable monitor functions.
DC power outputs:	+5VDC @ 250mA, +12VDC @ 25mA, -12VDC @ 25mA.
Data Port:	RS232. RS232 3 wire (TxD, RxD, Gnd).
Ground:	
Signal	Ground Floating. Grounded externally.
Power	Power stage optically isolated.

Motor encoder:

Inputs	
A,B,X	2.2kW internal pull-up to +5V. Differential or single-ended, 4 meg. Counts/ Sec. maximum.
Buffered outputs	
/Enc Buffout A	HCMOS, differential line driver, buffered encoder output A.
/Enc Buffout B	HCMOS, differential line driver, buffered encoder output B.
/Enc Buffout X	HCMOS, differential line driver, buffered encoder output X.
Hall inputs:	U,V,W. Single-ended, 10k Ohms internal pull-up to +5V.
Logic inputs:	TTL, 28V max. Group programmable; 22k Ohms internal pull-up to +5V or pull-down to 0V. Software programmable active Lo or Hi.
Enable	Enables amplifier within 5ms when active.
Pos enable	Enables positive rotation.
Neg enable	Enables negative rotation.
Reset	Resets latching fault condition, recovers in 1ms.

Thermal Requirements:

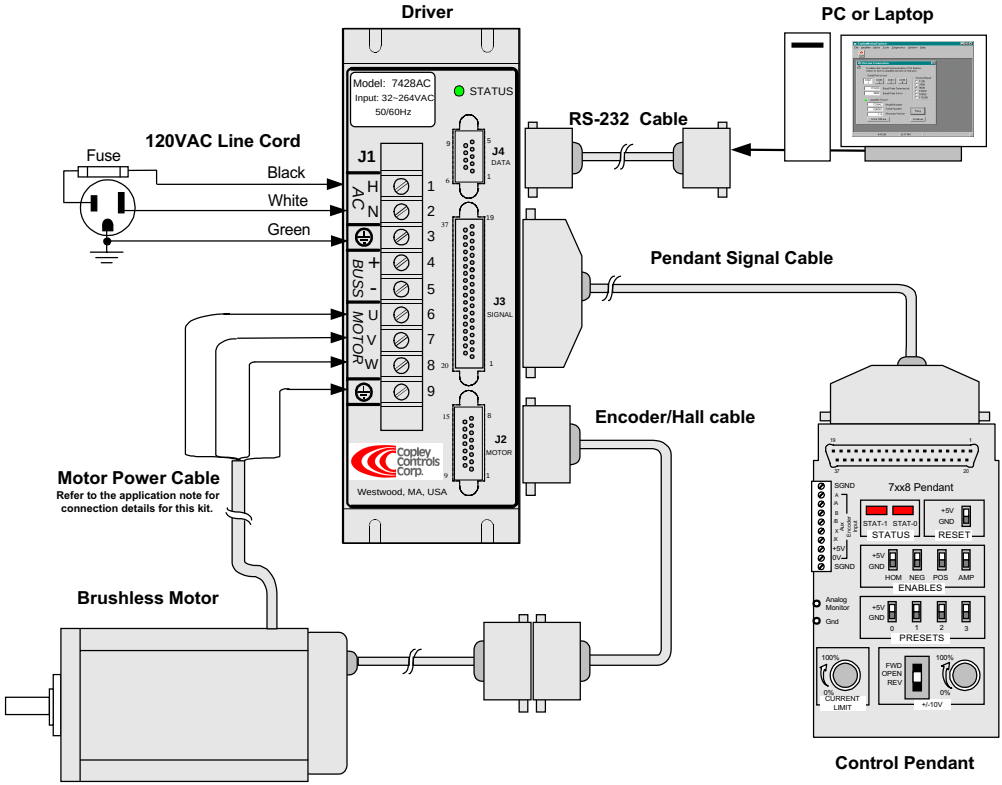
Storage temperature range	-30° C to +85° C
Operating temperature range	0° to 70°C baseplate temperature
Thermal resistance (heatplate to ambient)	
No heatsink or fan	2.7 deg C/W
No heatsink w/ fan	1.0 deg C/W
With heatsink / no fan	1.6 deg C/W
With heatsink and fan	0.4 deg C/W

Protection:

Output to output short	Latches unit OFF (will reset if Reset input is connected to Gnd, or when power is recycled).
Output to ground short	Latches unit OFF (will reset if Reset input is connected to Gnd, or when power is recycled).
Overtemperature	Latches unit OFF at 70° C on heatplate (will reset if Reset input is connected to Gnd, or when power is recycled).
Undervoltage	Shutdown at internal DC buss < 45VDC.
Overvvoltage	Shutdown buss > 195 VDC (Model 7228) or buss > 390VDC (Model 7428).
Current-limiting	Output current peak, continuous, and peak time limits programmed via RS232 port.

Connection Diagram

You can use the connection diagram when connecting a user supplied motor. See **Chapter 4, Using a New Motor**.



Appendix B Operator Pendant

The Operator Pendant (Figure B-1) is a module that connects to the signal bus in place of a Programmable Logic Controller (PLC). You can use the pendant in a system to test and debug your application. The pendant has a number of components that you can use:

- Switches for initiating signals and presets.
- Connectors for auxilliary encoder inputs and monitoring with a scope.
- Potentiometers for adjusting current and voltage.
- LEDs for status display.

Table B-1 describes pendant components.

Item	Function
Reset Switch	When GND, resets the system to a default state.
ENABLE	Functions as an on/off switch for the amplifier. Toggling the switch from on to off will cause the amplifier Status indicator to go from steady to flashing green. Normally, GND enables the amplifier.
POS and **NEG**	Enable rotation in one direction, while inhibiting it in the other. A +5V signal enables and GND disables motion in the indicated direction. (Dependent upon the **Active Level** on Amplifier Status Now! screen.)
Home Switch	The status of the Home line determines the status of the In Home switch. This is the actual zero position only if Homed to the Home switch.
REV/FWD Switch	In **Torque** mode, or Velocity +/- 10V Pos>Torque, you can change the bias voltage.
Current Limit Potentiometer	In any mode, when an external current is selected, you can control the peak current.
+/- 10 V Potentiometer	In **Torque** mode, you can adjust +/-10 V for +/-current (peak programed). In **Velocity** mode, you can adjust +/-10V for +/-Velocity (programed)
Analog Monitor	Test point for signal selected with **Analog Monitor** parameter on the Amplifier Status Now! screen.
Gnd	Test point for ground.
Auxiliary Encoder Inputs	Used for auxiliary encoder input signals, master encoder and other digital input modes (including Pulse and Digital).
Stat-1, Stat-0 Leds	Used to indicate whether a motion profile is active or a fault has occurred.

Table B-1 Pendant Components

NOTE: The default switch setting consists of all switches up position.

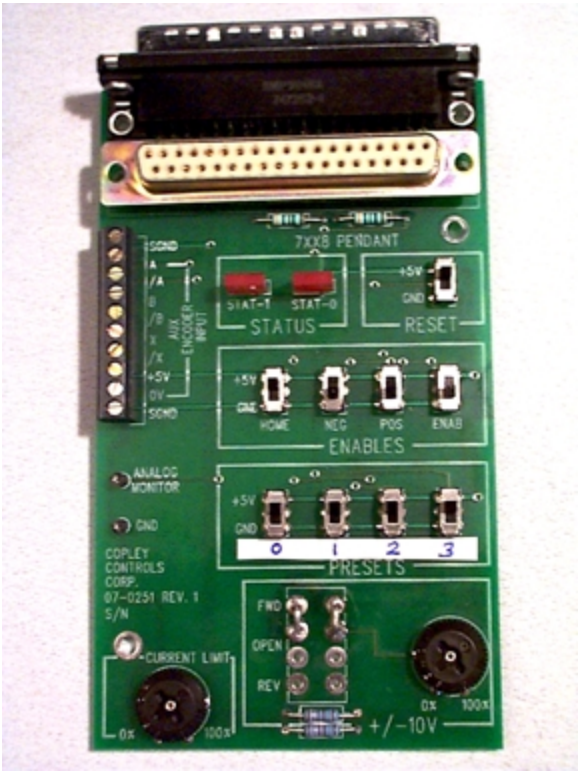


Figure B-1 Pendant Module

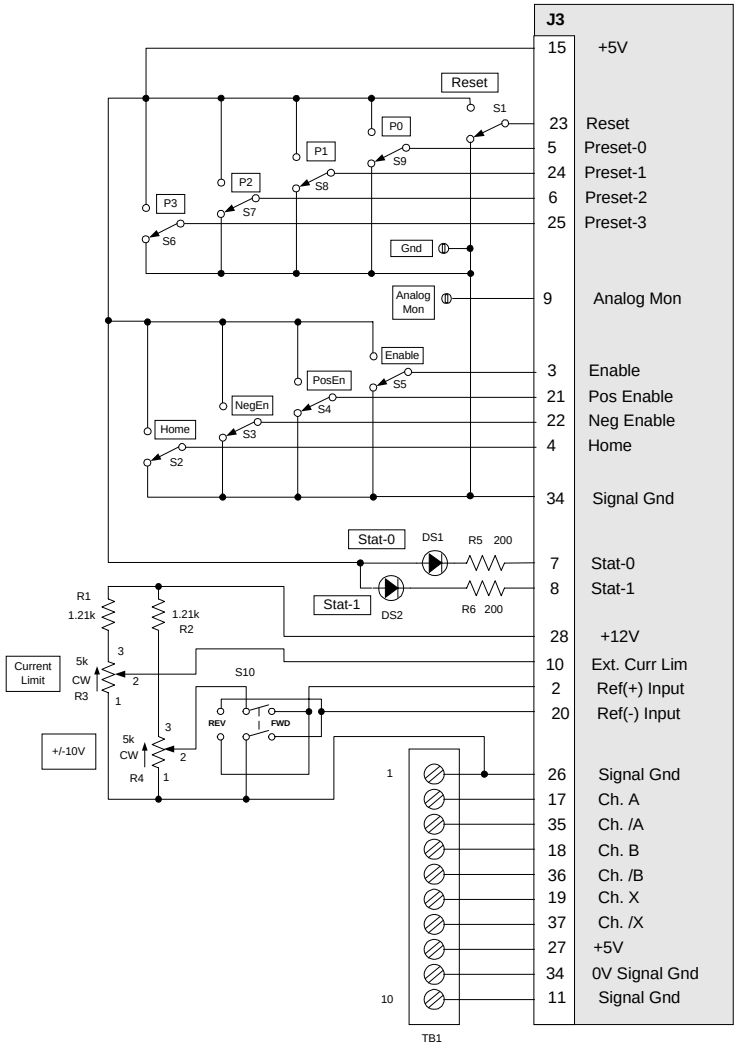


Figure B-2 Pendant Schematic

Appendix C Ordering Information

Refer to this appendix when ordering accessories, cables and development kits.

Amplifier	Features
7228AC	20A peak, 10A continuouse, from 32~132VAC, 50/60Hz AC mains
7428AC	20A peak, 10A continuouse, from 32~264VAC, 50/60Hz AC mains
7228DC	20A peak, 10A continuouse, from 45~186VDC, (32~132VAC rectified)
7428DC	20A peak, 10A continuouse, from 45~373VDC, (32~264VAC rectified)

Accessories	Features
Control Pendant	Hand controller with switches, potentiometers, and connections for testing
Software CD	CD rom with Copley Motion Explorer ™ Software
Users Guide	Printed Users Manual for the 7XX8 Digital Amplifier Series
Connector Kit	D-Sub 9-pin, 15-pin, and 37-pin Male Solder Cup with Backshell

Cables	Connections	Feet	Features
34MS-10	Military Style	10Ft	Twisted shielded cables for motor power and signal
23FL-6	Amp	6ft	Twisted shielded cable for size 23 & 16 motor power
120VAC Line	Plug	6ft	18 AWG USA power cord.
Data Cable	9pin D-Sub	6ft	Twisted shielded cable for RS-232 communication
Pendant Extention	37pin D-Sub	6ft	Twisted shielded cable for control pendant
Motor Signal Extention	15pin D-Sub	6ft	Twisted shielded cable for size 23 & 16 motor signal

Kit	Amplifier	Motor	Stall Torque	Peak Torque	Speed	NEMA	SHAFT
Kit-001	7228AC	CBL-162BE-001	44 oz-in	220 oz-in	6000rpm	Size 16	1/4" round
Kit-002	7428AC	CBL-232AE-001	92 oz-in	460 oz-in	4500rpm	Size 23	3/8" round
Kit-003	7228AC	CBL-232BE-001	98 oz-in	477 oz-in	6000rpm	Size 23	3/8" round
Kit-004	7428AC	CBL-233AE-001	144 oz-in	700 oz-in	2800rpm	Size 23	3/8" round
Kit-005	7228AC	CBL-233BE-001	140 oz-in	685 oz-in	6000rpm	Size 23	3/8" round
Kit-006	7228AC	CBL-341FE-001	102 oz-in	307 oz-in	6000rpm	Size 34	1/2" keyway
Kit-007	7228AC	CBL-343GE-001	288 oz-in	864 oz-in	4050rpm	Size 34	1/2" keyway

Notes:

1. **Kit Includes: Power cord, Data cable, Motor signal cable, Motor power cable, Connector Kit, Pendant cable, Pendant, Software CD and Users Manual.**
2. **Size 16 & 23 motors have flying leads with connector. Size 34 motors have military style connectors.**

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